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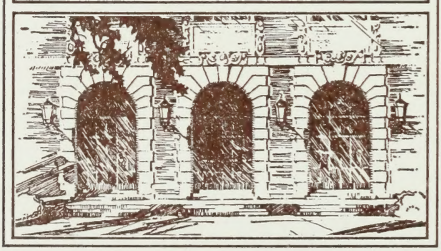

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UNIVERSITY OF ILLINOIS BULLETIN

VERSITY OF ILLINOIS GRADUATE COLLEGE

1968-1969 URBANA CAMPUS

UNIVERSITY OF ILLINOIS BULLETIN. Volume 65, Number 111; May 6, 1968. Published twelve times each month by the University of Illinois. Entered as second-class matter December 11, 1912, at the post office at Urbana, Illinois, under the Act of August 24, 1912. Office of Publication, 114 Altgeld Hall, Urbana, Illinois 61801.

It is the policy of the University of Illinois to afford equal educational opportunities to qualified persons regardless of race, religion, or ethnic background.

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IVERSITY OF ILLINOIS GRADUATE COLLEGE

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*Awards master's degree only.
†Awards master's degree in management only.

CALENDAR OF THE GRADUATE COLLEGE

Note: Information pertaining to foreign language examinations in French and German during the first and second semesters of 1968-1969 and the summer session of 1969 will be available by October, 1968.

Summer Session, 1968

June 17, Mon.-June 18, Tues. . . . . Graduate registration.

June 18, Tuesday . . . . . Instruction begins.

June 28, Friday . . . . . Applications to take the French or German examination on July 20 will not be accepted in Graduate College Office after this date.

July 4, Thursday . . . . . Independence Day (holiday).

July 12, Friday . . . . . Last day to add a course or change credit from units to hours or from hours to units.

July 12, Friday . . . . . Applications to take the Russian examination on July 26 will not be accepted in Graduate College Office after this date.

July 20, Saturday . . . . . French and German examinations.

July 20, Saturday . . . . . Last day for candidates for the master's degree in August to submit theses to Graduate College Office for approval of format.

July 22, Monday . . . . . Last day to drop a course.

July 26, Friday evening . . . . . Russian examination.

August 8, Thursday . . . . . No names will be added to the August graduation list after this date.

August 8, Thursday . . . . . Last day for candidates for the master's degree in August to deposit theses.

Aug. 9, Fri.-Aug. 10, Sat. . . . . Summer session examinations.

August 30, Friday . . . . . Last day for candidates for the doctoral degree in October to submit theses to Graduate College Office for approval of format.

September 6, Friday . . . . . Last day for candidates for the master's degree in October to submit theses to Graduate College Office for approval of format.

September 20, Friday . . . . . Last day to file application for the master's degree in October.

September 20, Friday . . . . . Last day for candidates for the master's degree in October to deposit theses.

September 21, Saturday . . . . . Last day for finals for the doctoral degree in October.

September 30, Monday . . . . . Last day for candidates for the doctoral degree in October to deposit theses and abstracts.

Deadline Dates For Submitting Applications For Admission or Readmission in September, 1968

July 31, Wednesday — Last day for foreign students who have *not* attended a college or university in the United States to apply for admission in September, 1968.

August 28, Wednesday — Last day for domestic students, or foreign students who have attended a college or university in the United States, to apply for admission or readmission in September, 1968.

First Semester, 1968-1969

Sept. 12, Thurs.-Sept. 14, Sat. to noon — Graduate registration. (Authorization cards distributed on alphabetical basis. Note: Employed school teachers registering for Saturday and evening classes should register Saturday morning, September 14. There will be no registration on Saturday, September 21.)

September 14, Saturday — Last day for registration without payment of late registration fine.

September 16, Monday — Instruction begins.

October 11, Friday — Applications to take the Russian examination on October 25 will not be accepted in Graduate College Office after this date.

October 25, Friday evening — Russian examination.

November 1, Friday — Last day to add a course or to change credit from units to hours or from hours to units.

November 16, Saturday — Last day for preliminary examination for the Ph.D. degree if thesis credit earned during the semester is to apply to the third stage of program.

November 22, Friday — Applications to take the Russian examination on December 13 will not be accepted in Graduate College Office after this date.

November 27, Wednesday, 1 P.M. — Thanksgiving vacation begins.

December 2, Monday, 1 P.M. — Thanksgiving vacation ends.

December 2, Monday, 1 P.M. — Advance enrollment for continuing students begins.

December 9, Monday.....Advance enrollment for continuing students ends.

December 13, Friday evening.....Russian examination.

December 20, Friday.....Last day for candidates for the master's degree in February to submit theses to Graduate College Office for approval of format.

December 21, Saturday, 1 P.M.....Christmas vacation begins.

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January 2, Thursday, 1 P.M.....Christmas vacation ends.

January 6, Monday.....Last day for candidates for the doctoral degree in February to submit theses to Graduate College Office for approval of format.

January 6, Monday.....No names will be added to the February graduation list after this date.

January 13, Monday.....Last day for candidates for the master's degree in February to deposit theses.

Jan. 13, Mon.-Jan. 21, Tues.....Semester examinations.

January 20, Monday.....Last day for finals for the doctoral degree in February.

January 27, Monday — Last day for candidates for the doctoral degree in February to deposit theses and abstracts.

Second Semester, 1968-1969

Jan. 30, Thurs.-Feb. 1, Sat. to noon.....Graduate registration. (Authorization cards distributed on alphabetical basis. Note: Employed school teachers registering for Saturday and evening classes should register Saturday morning, February 1. There will be no registration on Saturday, February 8.)

February 1, Saturday.....Last day for registration without payment of late registration fine.

February 3, Monday.....Instruction begins.

February 15, Saturday.....Last day for application for fellowships for 1969-1970.

February 28, Friday.....Applications to take the Russian examination on March 14 will not be accepted in Graduate College Office after this date.

March 1, Saturday.....Earliest date to apply for National Defense Student Loan fund for 1969-1970.

March 14, Friday evening.....Russian examination.

March 21, Friday — Last day to add a course or to change credit from units to hours or from hours to units.

March 22, Saturday — Last day for preliminary examination for the Ph.D. degree if thesis credit earned during the semester is to apply to the third stage of program.

March 29, Saturday, 1 P.M. — Spring vacation begins.

April 7, Monday — Last day to drop a course.

April 7, Monday, 1 P.M. — Spring vacation ends.

April 11, Friday — Applications to take the Russian examination on April 25 will not be accepted in Graduate College Office after this date.

April 23, Wednesday — Advance enrollment for continuing students begins.

April 25, Friday — Russian examination.

April 25, Friday — No names will be added to the June graduation list after this date.

April 30, Wednesday — Advance enrollment for continuing students ends.

May 2, Friday — Honors Day. Classes dismissed at noon.

May 12, Monday — Last day for candidates for the doctoral degree in June to submit theses to Graduate College Office for approval of format.

May 16, Friday — Last day for candidates for the master's degree in June to submit theses to Graduate College Office for approval of format.

May 23, Friday — Last day for candidates for the master's degree in June to deposit theses.

May 26, Monday — Last day for finals for the doctoral degree in June.

May 26, Mon.-June 4, Wed. — Semester examinations.

May 30, Friday — Memorial Day (holiday).

June 2, Monday — Last day to apply for National Defense Student Loan funds for 1969-1970.

June 2, Monday — Last day for candidates for the doctoral degree in June to deposit theses and abstracts.

June 14, Saturday — Commencement exercises.

Summer Session, 1969

June 16, Mon.-June 17, Tues. — Graduate registration. (Authorization cards distributed on alphabetical basis.)

June 17, Tuesday — Instruction begins.

July 4, Friday — Independence Day (holiday).

July 11, Friday.....Applications to take the Russian examination on July 25 will not be accepted in Graduate College Office after this date.

July 11, Friday.....Last day to add a course or to change credit from units to hours or from hours to units.

July 21, Monday.....Last day to drop a course.

July 25, Friday evening.....Russian examination.

July 28, Monday.....Last day for candidates for the master's degree in August to submit theses to Graduate College Office for approval of format.

August 4, Monday.....No names will be added to the August graduation list after this date.

August 7, Thursday.....Last day for candidates for the master's degree in August to deposit theses.

Aug. 8, Fri.-Aug. 9, Sat.....Summer session examinations.

August 29, Friday.....Last day for candidates for the master's degree in October to submit theses to Graduate College Office for approval of format.

September 5, Friday.....Last day for candidates for the doctoral degree in October to submit theses to Graduate College Office for approval of format.

September 15, Monday.....Last day to file application for the master's degree in October.

September 22, Monday.....Last day for candidates for the master's degree in October to deposit theses.

September 22, Monday.....Last day for finals for the doctoral degree in October.

September 29, Monday.....Last day for candidates for the doctoral degree in October to deposit theses and abstracts.

Deadline Dates For Submitting Applications For Admission or Readmission in September, 1969

July 30, Wednesday.....Last day for foreign students who have *not* attended a college or university in the United States to apply for admission in September, 1969.

August 27, Wednesday.....Last day for domestic students, or foreign students who have attended a college or university in the United States, to apply for admission or readmission in September, 1969.

The Graduate College

The University of Illinois has its oldest and largest campus at Urbana-Champaign, a community of 95,500 located 128 miles south of Chicago. Originally, it was established as the Illinois Industrial University, on the basis of the Land Grant College Act, by Governor R. J. Oglesby in 1868. The University opened its door with three full-time faculty members and fifty students. Now, one hundred years later, the total enrollment in the various branches of the University—the Graduate College and undergraduate colleges at Urbana, the Graduate College and professional colleges at the Medical Center, Chicago, and the Graduate College and undergraduate colleges at Chicago Circle—exceeds 45,000. The combined faculty and staff includes the full-time equivalent of more than 16,000 members.

The Graduate College of the University of Illinois at Urbana offers instruction leading to advanced degrees in over one hundred fields of learning. Graduate enrollment currently exceeds 7,500 students who represent every state and seventy foreign countries. Today, a graduate faculty of 1,500 implements the University of Illinois Statutes which charge the Graduate College with the responsibility "to safeguard and promote standards of graduate work and to promote and assist in the development of research in all fields."

Graduate work in the medical and dental sciences and in pharmacy is offered in Chicago at the University's Medical Center. Inquiries concerning these programs should be directed to the Graduate College, University of Illinois at the Medical Center, 1853 West Polk Street, Chicago (P.O. Box 6998, Chicago 60680). Graduate programs in a number of disciplinary areas also are available at the University's Chicago Circle campus. Information may be obtained by writing to the Graduate College, University of Illinois at Chicago Circle, 2037 University Hall, Chicago (P.O. Box 4348, Chicago 60680).

Graduate instruction offered at the Urbana campus is listed by areas on pages 3 to 5 and is described in detail within the departmental listings, arranged alphabetically in this catalog.

The general requirements for admission and the degree requirements established by the Graduate College are described in this introductory section. All candidates for degrees must meet these requirements as well as those specified by the major departments within the departmental listings.

UNIVERSITY RESOURCES

Libraries

The University Library's resources for advanced study and research are outstanding. Its present collections now exceed 4,312,500 volumes, all but about 389,300 of them located in Urbana. The remainder are held by the Library of Medical Sciences in Chicago and the library at Chicago Circle.

In addition to the figures for cataloged volumes cited above, the University Library contains approximately 560,520 pamphlets, 373,060 maps and aerial photographs, and 308,931 music scores and parts. More than 20,000 periodicals and newspapers are currently received.

Outstanding collections have been developed for a variety of fields. In the humanities, strong areas include classical literature, history, and archaeology; sixteenth- and seventeenth-century English literature, especially the Milton-Shakespeare period; eighteenth-twentieth century English literature, American humor and folklore; French, Italian, and Spanish literature; German literature of the sixteenth and seventeenth centuries; and comparative philology. In the fine arts, collections in architecture, landscape architecture, and music are noteworthy.

In the social sciences, the Library's holdings are significant for western United States history, Abraham Lincoln and the Civil War, Latin-American history of the Revolutionary period, Italian history, medieval and modern European history, German history from 1830-1900, Irish history, Slavic history and literature, international law and relations, political science law, economics, labor and industrial relations, and education.

For science and technology, collections of high rank are held in mathematics, chemistry, biological sciences (especially parasitology, entomology, and ornithology), physics, geology, engineering, and agriculture.

The Library's bibliographical facilities comprise a general catalog of more than 5,000,000 cards, printed catalogs of libraries, e.g., the Bibliothèque Nationale, British Museum, and Library of Congress; national and trade bibliographies of all countries for which such works have been issued; bibliographies of special subjects; and similar aids.

A number of departmental and divisional libraries are maintained.

Following are the principal collections in the main library building: Classics, Commerce, Education and Social Science, English, History and Philosophy, Human Relations Area Files, Library Science, Map and Geography, Modern Language, Newspaper, Physical Education, Rare Book Room, and Undergraduate Library.

Elsewhere on the campus are departmental libraries for the following fields: Agriculture, Architecture and Fine Arts, Biology, Ceramics, Chemistry, City Planning, Engineering, Geology, Home Economics, Journalism and Communications, Labor and Industrial Relations, Landscape Architecture, Law, Mathematics, Music, Natural History Survey (entomology and other biological sciences), Physics, and Veterinary Medicine.

Further facilities available for graduate students are the general bookstacks, housing about 2,500,000 volumes, and over 300 carrels in the bookstacks, assigned to individuals engaged in extended study and research. Interlibrary loan service from other institutions is provided for those engaged in research for dissertations.

Special Laboratory Facilities

Digital Computers. See Department of Computer Science, page 129.

Electron Microscope Facility. The Electron Microscope Laboratory, located in the basement of Bevier Hall, is a central facility for instruction and research in behalf of all University departments. It is equipped with a Siemens Elmiskop 1, a highly modified Hitachi HS-6, RCA models EMU-3C, EMU-2C, and EMU-2E electron microscopes, and a Cambridge Stereoscan electron microscope. Ancillary equipment includes five ultramicrotomes, two shadowcasters, an RCA electron diffraction unit, and two complete photographic darkrooms and general facilities.

The instructional program consists of the following courses: Biology or Chemistry 423, Electron Microscopy; Biology or Chemistry 429, Electron Microscopy with Laboratory; Biology or Chemistry 493, Advanced Electron Microscopy; Biology 430, Biological Ultrastructure; and seminars and special workshops. The facilities are available for research conducted by qualified members of the faculty and graduate students.

Physical Environment Unit. The facilities of the Physical Environment Unit provide unique opportunities for pursuing interdisciplinary researches on the responses of biological systems to stresses imposed by the physical environment. An altitude chamber accommodating six human beings permits simulation of altitudes up to 45,000 feet. Air temperature and humidity may be controlled in this chamber to permit investigation of the combined stresses of low environmental pressure and

heat or cold. Additional controlled environment rooms provide flexible areas where special test facilities may be installed. The Physical Environment Unit serves as the focus for teaching and research in the course sequence on ergonomics, offered jointly by the Departments of Physiology and Biophysics, and Industrial Engineering. All departments and divisions of the University needing closely controlled environment conditions for research or instructional work may utilize the special skills and equipment available in the Unit.

Radiocarbon Laboratory. The Radiocarbon Laboratory is an all-University facility for graduate training and research involving the use of the tracer technique with carbon-14 and/or tritium. It is equipped with liquid scintillation spectrometers, vibrating reed electrometers, gas counters, radio-gas chromatography units, high vacuum systems, combustion set-ups, and auxiliary radiochemical equipment.

A prerequisite for research in the Laboratory is the carbon-14 course, Chemistry and Animal Science 496, which emphasizes experimental techniques employed in the synthesis, degradation, isolation, establishment of purity, and assay of radioactive carbon compounds. Members of the staff present this course one semester each year.

Social and Cultural Facilities

Students at the University of Illinois have a wide choice of activities and facilities available to them. Campus events announced in a weekly calendar include musical programs, lectures, University forums, campus and traveling theatrical productions, weekend movies and dances, and fine arts and scientific exhibitions.

The Krannert Art Museum provides galleries for displaying the University's permanent collection of art works and for presentation of other exhibitions. A University Festival of Contemporary Arts, held every two years, includes special events and exhibits in the areas of art, architecture, landscape architecture, urban planning, drama, motion picture, literature, printing, dance, and music. Illini Union, the campus social center, has lounges, dining facilities, and recreational and meeting rooms available to students and faculty.

Military Science (Reserve Officers' Training Corps)

Army R.O.T.C. is offered at the University of Illinois as outlined in the Undergraduate Study catalog.

A student in a graduate or professional course who completed the basic course as an undergraduate or who has received appropriate credit

may be enrolled in the advanced course any time prior to the beginning of the last two years of his graduate program, providing he meets the eligibility requirements listed in the Undergraduate Study catalog.

This special two-year advanced program is offered for students who have two academic years remaining at the University, but who did not take the basic course through on-campus instruction. Under this program, the basic course is accomplished by completion of a summer training camp of not less than six weeks' duration at an active army installation. While attending this camp, students are paid at the same rate as a basic trainee; and they are allowed travel expenses to and from camp.

Further information may be obtained from the Professor of Military Science, 113 Armory, University of Illinois, Champaign, Illinois 61820.

ADMISSION

General Requirements

It is recommended that prospective students apply for admission at least two months before the beginning of the term in which they expect to enroll. Applications for admission or readmission, including all supporting documentation, *must be submitted* by domestic students no later than two weeks prior to registration or by foreign students at least six weeks prior to registration.

A nonrefundable deposit of $30.00 on tuition and fees is required of all *new and readmitted domestic graduate students amd all foreign students who are presently residing in the United States.* This deposit should not be sent until requested by the University. Graduate students assured of the award of a fellowship, assistantship, or tuition and fee waiver are permitted to confirm their intention to enroll without payment of the advance deposit.

Admission forms may be obtained from the Office of Admissions and Records, 100a Administration Building, or from the Graduate College, 330 Administration Building.

An applicant will be considered for admission to the Graduate College if (1) he is a graduate of an institution awarding a baccalaureate degree comparable to that granted by the University of Illinois; (2) he is adequately prepared for advanced study as demonstrated by his previous program of study and his scholastic record; and (3) he is recommended for admission by his major department and the Dean of the Graduate College.

The prerequisites for advanced work in the various fields of specialization are listed in the departmental sections of this catalog. Also listed

are the scholastic grade-point average requirements which must be met before an application for admission is considered. The scholastic average is expressed in terms of a five-point scale (A = 5.0; B = 4.0; etc.).

The grade-point average of an applicant for master's candidacy is computed from the last sixty semester hours of course work completed, including undergraduate and any graduate courses taken. An applicant for post-master's and doctoral candidacy who has earned a master's degree or at least thirty-two semester hours of graduate study is considered for admission on the basis of two scholastic grade-point averages: one average for the last sixty semester hours of undergraduate study and the other for all graduate course work completed to date.

A department's recommendation with respect to the admission of an applicant is not based solely on the scholastic average. Therefore, not all who meet the scholastic requirements can be admitted.

Admission Status

A permit to enter the Graduate College, which is issued to each new or readmitted graduate student, indicates the student's status as follows:

Status No. 1: Full graduate standing at the master's level.

Status No. 2: Full graduate standing at the post-master's or doctoral level.

Status No. 3: Limited standing. This is a probationary status for students (1) who have less than a 3.5 grade-point average; (2) who have departmental deficiencies to be removed during the first year; (3) who are currently enrolled as undergraduates; (4) who present foreign credentials which must be evaluated at the time of registration.

Status No. 4: Non-degree standing. This status is limited only to those applicants who have *no intention* of pursuing a graduate degree at the University of Illinois.

Summer Session

In addition to a two-semester academic year, the University conducts an eight-week summer session at Urbana. New students applying for admission to the Graduate College for the summer term should submit applications for admission as early as possible, preferably no later than May 15 preceding the first day of instruction for the summer session. Former students expecting to attend the summer session should apply for readmission no later than May 15, unless one of the following situations applies.

Authorization cards permitting campus registration in a summer session are automatically prepared for graduate degree candidates who

were registered on the Urbana campus in the summer session the year preceding. Cards also are prepared automatically for graduate degree candidates who were registered on the Urbana campus for the spring semester prior to the summer session, and for candidates who were registered in extramural classes during the fall or spring semester immediately prior to the summer session.

If a student was registered during any above-mentioned period and did not withdraw from the University during his last enrollment, he does not need to apply for readmission to the summer session. Persons who were not enrolled during these terms, or who dropped all courses being taken during their last registration, must apply for readmission if they expect to attend the Urbana summer session. Readmission applications may be obtained from the Office of Graduate and Foreign Admissions, 100a Administration Building.

Because existing facilities are inadequate to accommodate all qualified applications for admission and readmission in the fall semester, acceptance in the summer session as a non-degree candidate does not guarantee approval for continuation in the following semester, unless the applicant has previously been approved for admission as a candidate for a degree and has paid an advance deposit on his tuition and fees for the fall semester.

Physical Examination

Each new student proposing to enroll in the University of Illinois at Urbana-Champaign for a full semester is required, before completion of his registration, to present adequate evidence of satisfactory physical and mental health as determined by the Director of Health Services of the University.

Part-time graduate students enrolling for one unit, or five hours, or less, are not required to have a physical examination except in those instances when the Director of Health Services considers the physical examination, in addition to the required tuberculin test, advisable for the protection of the health of other students.

Former and continuing students may also be required to present adequate evidence of satisfactory physical and mental health prior to readmission or registration and continuation in the University. All former students re-entering after an absence of one semester or longer are required to have the tuberculin test as a condition of registration. All students who have lived abroad for an academic year or its equivalent are required to have a complete physical examination when returning to reregister in the University.

A new student enrolling in the summer session is required to take the tuberculin test administered by the Health Service without charge as a part of the registration procedure, but is not required to take the physical examination until such time as he enrolls for a full semester. Anyone who has had a normal chest film within the past six months, and presents evidence thereof, is excused from the tuberculin test.

A complete physical examination, including chest X-ray, performed by the University Health Service, is required of all foreign students prior to receipt of a permit to enter the University, including those foreign students whose first enrollment at the University of Illinois is in the summer session. This examination is given by the Health Service without charge.

Detailed explanatory material and medical forms for reporting the pre-entrance examination are forwarded to each student who receives a permit to enter.

Graduate Study by Seniors at the University of Illinois

A senior at the University of Illinois whose academic average for his junior and senior work is 4.0 or above may apply for admission to the Graduate College if he is *within five hours* of his baccalaureate degree. If he is *within ten to six hours* of that degree he may apply to take some work for graduate credit. Forms describing the procedure to be followed are available at the Graduate College Office.

Readmission

A former student who has not registered for one or more semesters must file an application for readmission. This form should be submitted to the Office of Admissions and Records as early as possible and not later than two weeks before the beginning of the term in which he expects to register. A nonrefundable deposit of $30.00 on tuition and fees is required of all students seeking readmission, unless they have been assured of the award of a fellowship, assistantship, or tuition and fee waiver.

Foreign Applicants

A student from abroad who wishes to be admitted to graduate study at the University of Illinois should write to the Office of Admissions

and Records, 100a Administration Building, Urbana, Illinois 61801. He should enclose with his initial inquiry for admission, copies of his complete academic records which have been officially certified by the educational institutions he has previously attended. These official records should include a listing of all final degrees, diplomas, or certificates awarded.

An authenticated English translation must accompany all documents that are in a language other than English.

A prospective applicant must also provide the following information: full legal name; address to which reply should be mailed; place and date of birth; name of the country of which he is now a citizen; marital status; form of permanent physical handicap, if any; the subject in which he wishes to specialize; native language; whether he wishes to be a candidate for an undergraduate or graduate degree; amount in United States dollars available for support, the source of income, and the length of time this support is guaranteed; a complete chronological list of all elementary and secondary schools, and colleges attended, with the exact dates of attendance, and diplomas, certificates, or degrees received; if he is not attending school, his occupation since leaving school; the date he plans to enter.

Because it is not advisable to undertake a graduate program at the University of Illinois without adequate competence in the English language, all applicants whose native tongue is not English are required to take the Test of English as a Foreign Language (TOEFL). Applicants may make arrangements to take this test by writing to the Educational Testing Service (ETS), Princeton, New Jersey, United States of America, and requesting that they be tested in their home country. Applicants must request that ETS send a copy of their test results to the Office of Admissions and Records. Qualified applicants who have been recommended for admission by their major departments will receive from the Office of Graduate and Foreign Admission permits to enter and an appropriate certificate to apply for a visa to enter the United States.

Military Deferment

The Selective Service System through the local board determines the student's deferment status. Generally, the following criterion is used as a guide for deferment:

Verification from the Graduate College that the student is satisfactorily pursuing a full-time program of study. A full-time program involves (a) three or more units of graduate study, (b) a program of both graduate and undergraduate courses equivalent to twelve or more semester hours,

(c) two and one-half units plus an appointment for not less than one-third time, or (d) two units of graduate study and an appointment as a teaching or research assistant for not less than one-half time.

It is the student's responsibility to initiate the appropriate request or form that will enable the University to send accurate information to his local board. A student who has been issued a permit to enter the Graduate College but who has not had an opportunity to register, may request the Selective Service clerk in the Office of Admissions and Records, 69 Administration Building, to notify his local board of his acceptance.

A student who is registered should obtain a Status Form for Graduate Students Seeking Deferment from his major department or the Graduate College. This form must be completed by the student, certified by the executive officer of the major department, and filed with the Office of Admissions and Records, 69 Administration Building, at the times shown below:

(1) When the student first registers and every September thereafter.
(2) When a "change of program" is initiated which will reduce the student's program to less than three units or the equivalent (twelve semester hours).
(3) When the student's degree objective or anticipated degree date changes.

The University may inform and justify, but has no control over decisions made by the Selective Service System. A student who is reclassified by his board and who wishes to appeal the reclassification should notify his local board in writing that he wishes to appeal. The right to appeal is forfeited 30 days after the reclassification date.

FEES AND EXPENSES

Expenses

Although personal expenses may vary according to the individual needs and benefits, the following estimates indicate the average basic living costs for single students. Cost of weekly board ranges from $20.00 to $25.00, single rooms in private student houses from $35.00 to $55.00 a month, and double rooms from $35.00 to $50.00 a month for each person. In some cases, apartments are shared and the monthly costs per person can be from $50.00 to $60.00, plus the cost of utilities. Graduate halls operated by the University offer single rooms at rates ranging from $424.00 to $518.00 for the academic year and double rooms at rates ranging from $360.00 to $486.00 per person for the same period.

A board contract may be purchased for one semester at a rate of approximately $246.00.

Tuition and Fees

Tutition and other fees, as indicated below, are payable in full when the student registers, unless the installment plan of payment is elected. An additional charge of $2.00 is made for this privilege.

SEMESTER

	Full Program		*Partial Programs*			
	Range I		Range II		Range III	
	Above 10 hours Above 2½ units		Above 5 to 10 hours Above 1¼ to 2½ units		Above 0 to 5 hours Above 0 to 1¼ units	
	Resident	Non-resident	Resident	Non-resident	Resident	Non-resident
Tuition (except those holding exemptions)	$ 85.00	$375.00	$60.00	$265.00	$35.00	$155.00
Service Fee[1]	40.00	40.00	25.00	25.00	10.00	10.00
Hospital-Medical-Surgical Insurance Fee[2]	10.00	10.00	10.00	10.00	10.00	10.00
Total	$135.00	$425.00	$95.00	$300.00	$55.00	$175.00

TWELVE-WEEK SUMMER TERM (INSTITUTES) AND ELEVEN-WEEK SUMMER LAW PROGRAM*

	Full Program		*Partial Programs*			
	Range I		Range II		Range III	
	Above 8 hours Above 2 units		Above 4 to 8 hours Above 1 to 2 units		Above 0 to 4 hours Above 0 to 1 unit	
	Resident	Non-resident	Resident	Non-resident	Resident	Non-resident
Tuition (except those holding exemptions)	$ 65.00	$250.00	$45.00	$175.00	$25.00	$ 90.00
Service Fee[1]	30.00	30.00	20.00	20.00	10.00	10.00
Hospital-Medical-Surgical Insurance Fee[2]	10.00	10.00	10.00	10.00	10.00	10.00
Total	$105.00	$290.00	$75.00	$205.00	$45.00	$110.00

* Students registered in *either one* of the five and one-half week summer law sessions pay one-half of the tuition and service fee established for the twelve-week term, rounded to the next higher even dollar. They are also subject to the same Hospital-Medical-Surgical Insurance Fee applying to registrants in the eight-week summer session.

EIGHT-WEEK SUMMER SESSION

	Full Program		*Partial Programs*			
	Range I		Range II		Range III	
	Above 5 hours Above 1 ¼ units		Above 2½ to 5 hours Above ¾ to 1 ¼ units		Above 0 to 2½ hours Above 0 to ¾ units	
	Resident	Non-resident	Resident	Non-resident	Resident	Non-resident
Tuition (except those holding exemptions)	$ 45.00	$190.00	$30.00	$130.00	$20.00	$ 80.00
Service Fee[1]	20.00	20.00	15.00	15.00	5.00	5.00
Hospital-Medical-Surgical Insurance Fee[2,3]	10.00	10.00	10.00	10.00	10.00	10.00
Total	$ 75.00	$220.00	$55.00	$155.00	$35.00	$ 95.00

NONCREDIT COURSES

Students (except those holding exemptions) who register in noncredit courses pay tuition and fees as follows:

(1) Persons who register *on campus* for doctoral thesis research (499) only, without credit, are charged the following:

SEMESTER:

Tuition	$10.00
Service Fee	10.00
Hospital-Medical-Surgical Insurance Fee	10.00

EIGHT-WEEK SUMMER SESSION:

Tuition	$10.00
Service Fee	5.00
Hospital-Medical-Surgical Insurance Fee	10.00

(2) Persons who register for doctoral thesis research (499) *in absentia* without credit are charged only a tuition fee of $10.00

(Those registered *in absentia* for credit pay the regular tuition, resident or nonresident, as applicable.)

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[1] Persons on appointment for at least 25 per cent of full time on the academic, administrative, or permanent nonacademic staff of the University, or on the staffs of allied agencies, and persons registering *in absentia* or in courses conducted off-campus are exempt from the service fee.

[2] Students presenting evidence of equivalent coverage may receive a waiver of this fee upon approval of a petition submitted to the University Insurance Office not later than the final day established for full refund of fees. A signed waiver and assumption of responsibility is required. Persons registered for thesis research *in absentia* are not assessed this fee.

[3] If insurance coverage for the period between the close of the summer session and the beginning of the first semester is not desired, $5.00 will be refunded if requested in writing prior to the final date established for full refund of fees.

(3) Persons who register in noncredit seminars, either alone or in addition to other courses ..... *No charge*
(Regular tuition and fees which are applicable are assessed for other courses taken concurrently.)

(4) Persons who register in noncredit courses in addition to credit courses pay ..... *No additional charge*
(If taken alone, registrations in noncredit courses other than thesis research and seminars are assigned to Range III.)

(5) University employees who register at the request of their department in noncredit courses especially established to improve the work of the employee ..... *No charge*
(Regular tuition and fees which are applicable are assessed for other courses taken concurrently.)

(6) Persons wishing to attend a campus course as a visitor only (special permit required) pay for each course a fee of $15.00

Residence Classification

The residence classification of an applicant is determined on the basis of information given on his application and other credentials. Tuition is assessed in accordance with this decision. If the student believes he has a legitimate cause for change of status, he may, be petition, on a form provided by the Office of Admissions and Records, request a change. Petitions are considered *within thirty days* from the date designated in the official University Calendar as that upon which instruction begins for the academic period for which the charge is payable. However, if the nonresident tuition was not assessed on or prior to that date, the claim for refund may be filed *within thirty days* after the nonresident tuition was assessed and the student was given notice of its assessment. Tuition and fees will not be adjusted for that academic term because of change in residence classification if the petition is not filed within these time limits. Additional evidence to substantiate a request may be required. If the student expects to ask for a change of residence classification, it is advisable for him to request the adjustment be made prior to the registration period.

In the event a student who claims he is a resident student is dissatisfied with an adverse ruling of the Director of Admissions and Records, he may obtain a review of such decision by the Legal Counsel of the University by filing a written request with the Director of Admissions and Records within twenty days after he has been notified of the ruling. In such cases, the decision of the Legal Counsel is final.

Further information concerning residency may be secured by contacting the Office of Admissions and Records, 100a Administration Building, Urbana, Illinois 61801. A brochure entitled *Regulations Governing Assessment of Reisdent or Nonresident Student Fees* is also available.

Special Fees

Below is a partial list of special fees pertaining to graduate students. A complete schedule of tuition and fees may be obtained from the Office of Admissions and Records, 69 Administration Building.

Late Registration Fine—$15.00. All students, whether on appointment or not, who complete registration for courses on campus after the close of the regular registration, are subject to this fine in addition to the tutition and fees. A student's registration is not complete until his tuition and fees have been paid in full, or he has made arrangements with the Bursar's Office for deferment of payment. Students who register late in any term pay the same tuition and fees as students who register at the beginning of the term.

Change of Program Fee—$1.00. This fee is charged for every course change slip issued at the request of the student after the completion of registration.

Exemptions. A student may be exempted from one or more of the usual charges if he qualifies under the following conditions:

TUITION IS WAIVED FOR:

(1) Holders of tuition waiver scholarships.
(2) All academic employees of the University or of allied agencies on appointment for at least 25 per cent but not more than 67 per cent of full-time services.
(3) All permanent nonacademic employees of the University or allied agencies on appointment for at least 25 per cent of full time who register in University courses in Range II or III.
(4) Holders of graduate tuition and fee waivers awarded by the Graduate College.
(5) Holders of grants or contracts from outside sponsors which provide payments to cover the total costs of instruction.
(6) Cooperating teachers and administrators who receive assignment of practice teachers. (Exemption is provided in one semester, quarter, or summer session for each semester or quarter of assignment within the same calendar year—September through August.)
(7) Persons registered in noncredit seminars only.
(8) University employees registered at the request of their departments in noncredit courses especially established to improve the work of the employee.
(9) Academic staff members emeriti.

NONRESIDENT PORTION OF TUITION (IF SUBJECT TO PAYMENT OF TUITION) IS WAIVED FOR:

(1) All staff members (academic, administrative, or permanent non-academic) on appointment for at least 25 per cent of full time with the University or the allied agencies.

(2) The faculties of state-supported institutions of higher education in Illinois.

(3) The teaching staff in the private and public elementary and secondary schools in Illinois.

(4) The spouses and dependent children of those listed in items 1 and 2 above. (Dependent children are those who qualify as dependents for federal income tax purposes.)

(5) The spouses and dependent children of fellows and trainees who are employed as teaching assistants permitted by their fellowship appointment.

(6) Persons actively serving in one of the Armed Forces of the United States who are stationed and present in the state of Illinois in connection with that service.

(7) The spouses and dependent children of those listed in item 6 above, as long as they remain stationed, present, and living in this state.

Vehicle Registration. All resident students enrolled in the Graduate College who have a motor vehicle in their possession are required to register this vehicle with the Motor Vehicle Division. The fee assessed is $5.00, except that graduate students holding fellowships or teaching or research appointments for at least one-half time have the option of securing at no cost a registration permit with reduced parking privileges.

Student motor vehicle registrations are effective from September 1 to September 1 of each year with all interim registrations (including new, transfer, and returning students) being effective until the following September 1. All motor vehicles in possession of students must be registered within one school day of the acquisition of such vehicles.

The Motor Vehicle Division requires the registration of all motorcycles, motor scooters, and motor bicycles. The fee for such registration is $3.00 per year.

Regulations governing use of motorcycles have been revised. Students should contact the Motor Vehicle Division before operating a motorcycle in the University community.

Bicycles also must be registered with this Division every year. No fee is charged for such registration.

Questions relating to vehicle regulations should be referred to the

Motor Vehicle Division, 101 North Mathews Avenue, Urbana, Illinois 61801.

Assessments and Exemptions

Assessments. For tuition and fee assessment purposes, a staff appointment must require service for not less than three-fourths of the term. This is interpreted as a minimum of three and one-half months in a semester, nine weeks in a quarter, and six weeks in an eight-week summer session. Staff tuition and fee privileges do not apply to students employed on an hourly basis in either an academic or nonacademic capacity, or to persons on leave without pay.

For fee assessment purposes, a *permanent* nonacademic employee is defined as a person who has been assigned to an established, permanent, and continuous nonacademic position and who is employed for at least 25 per cent of full time.

University employees appointed to established Civil Service positions whose rate of pay is determined by negotiation, prevailing rates, union affiliation, etc., are not considered as paid on a hourly basis and are entitled to the same tuition and fee privileges accorded to other staff members under the regulations.

Any student who resigns his staff appointment, or whose appointment is cancelled before rendering service for at least three-fourths of the term, becomes subject to the full amount of the appropriate tuition and fees for that term unless he withdraws from his University classes at the same time the appointment becomes void. Such students are not assessed tuition and fees for that term if they file clearance for graduation within one week after the appointment becomes void.

For those listed in items 1 through 4 on page 28, who are eligible for such waiver in the final term of the academic year, except as indicated under summer session below, this privilege is also extended to the summer session immediately following.

SERVICE FEE IS WAIVED FOR:

(1) All staff members of the University or allied agencies on appointment for at least 25 per cent of full time.

(2) Holders of graduate tuition and fee waivers awarded by the Graduate College.

(3) Students registered *in absentia.*

(4) Students registered in courses taught off campus.

(5) Holders of grants or contracts from outside sponsors if this fee is charged to the contract or grant funds.

(6) Cooperating teachers and administrators described under tuition waivers, item 6 on page 28.

(7) Persons registered in noncredit seminars only.

(8) University employees registered at the request of their departments in noncredit courses especially established to improve the work of the employee.

(9) Academic staff members emeriti.

HOSPITAL-MEDICAL-SURGICAL INSURANCE FEE IS WAIVED FOR:

(1) Students presenting evidence of equivalent coverage upon approval of a petition presented to the University Insurance Office not later than the final day established for full refund of fees.

(2) Persons registered for thesis research *in absentia.*

(3) Holders of grants or contracts from outside sponsors if this fee is charged to the contract or grant funds.

(4) Students for whom this fee has been assumed by the Graduate College.

(5) Persons registered in noncredit seminars only.

(6) University employees registered at the request of their departments in noncredit courses especially established to improve the work of the employee.

SUMMER SESSION TUITION AND FEES ARE WAIVED FOR:

(1) Students holding academic appointments to the close of the final term of an academic year either as employees or fellows, and for whom tuition and/or fees have been provided through waiver or through cash payment by an outside agency, are entitled to a waiver of the same kinds of tuition and fees for the summer session immediately following, provided they hold no appointments during that summer session.

(2) Students holding summer session appointments as fellows or as employees are subject to such tuition and fees as would be assessed in accordance with the principles expressed above.

Advance Deposit

Each new, readmitted, and advance enrolled continuing student (except foreign students who, at the time of application, are residing outside the United States, and certain others specifically exempted) who wishes to register for a fall semester is required to make an advance deposit in order to secure the place reserved for him. New and

readmitted students wishing to enroll in the spring semester are also required to make an advance deposit.

This is not an additional cost for attending the University but is applied to each student's tuition and fees in the semester for which he is approved. In case the student fails to enter the University in that semester, the deposit may not be applied toward any future registration. However, upon request, applicants approved for admission in the fall who later decide to enter the University in the immediately preceding summer session may apply their $30.00 advance deposit on their assessment for that summer session. The deposit should not be sent until requested by the University. It is nonrefundable except in very special cases.

The following graduate students may confirm their intentions to register without payment of the advance deposit:

(1) All new foreign students residing outside the United States at the time of application.

(2) New, readmitted, and advance enrolled continuing graduate students, holding a fellowship, academic or nonacademic staff appointment, or graduate tuition and fee waiver.

(3) New, readmitted, and advance enrolled continuing graduate students who receive a financial award from an agency outside the University, and whose complete tuition and service fee are billed to the agency by the Bursar.

(4) Doctoral candidates who have passed the preliminary examination.

Housing

The University has residence facilities in Arthur Hill Daniels Hall and Stuart Pratt Sherman Hall, two separate residence hall complexes for approximately 1,000 single graduate students, both men and women. Semester contract food service in undergraduate dining halls can also be arranged. In addition, the University provides a limited number of apartments for married students, with priority in assignment given to part-time research and teaching assistants.

Applications for accommodations in the University graduate residence halls or the University-owned apartments for married students may be obtained from the Housing Division, 420 Student Services Building, Champaign, Illinois 61820. The Housing Division also maintains a courtesy list of private apartments and rooms available in homes in the community. Office hours are from 8:00 a.m. to 12:00 noon and 1:00 to 5:00 p.m. Monday through Firday, and from 9:00 a.m. to 12:00 noon each Saturday. During the weekend prior to registration,

office hours also are maintained from 1:00 to 4:00 p.m. Saturday and 10:00 a.m. to 12:00 noon and 2:00 to 4:00 p.m. Sunday. University offices are not open on national holidays.

Installment Plan for Payment of University Fees and Housing Charges

Students registered on the Urbana-Champaign campus are given the option of paying tuition, fees, and residence hall charges (in the case of single graduate student housing only) on an installment basis. Tuition and fee charges for each of the first and second semesters are collected in four installments, the first payable at registration and the remaining in each of the following months. The advance deposit, if paid, is applied against the first installment. If this results in overpayment, the remainder is applied against subsequent installments. Summer session charges are payable one-half at registration and one-half during the following month. This plan does not apply to registration in extramural and correspondence courses. University housing for married students is contracted on an annual lease basis and payments are made by the month.

Students electing the installment plan for payment of tuition and fees are assessed a $2.00 service charge. An additional service charge of $2.00 is assessed in the case of the flight instruction fee of $375.00 if paid on the installment basis. There is no service charge for the payment of University housing accounts on the installment basis. Arrangements for payment on the installment plan are made with the Business Office during registration. An installment is considered delinquent on the first day of the month following the date payment is due. Penalties may be imposed on students who permit their accounts to become delinquent, including cancellation of registration.

Refund of Fees

A student subject to tuition and/or fees who files clearance papers for withdrawal from the University during any semester, quarter, or summer session, for reasons other than military or other approved national defense service, receives a refund as listed below. (Special refund regulations govern withdrawals for active military or other approved national defense service.)

IN A SEMESTER:

(1) During the first ten days of instruction in a semester, refund is made of the full amount of the tuition and fees assessed except for

a nonrefundable charge of $30.00.[1] When the total assessment has been less than $30.00, the full amount of the assessment, if any, is nonrefundable.

(2) After the first ten days but within the first half of the semester, one-half of the total amount of the tuition and fees assessed which remains after deduction of the nonrefundable charge is refunded.

(3) After the midpoint of the semester, no refund is allowed.

IN AN EIGHT-WEEK SUMMER SESSION:

(1) During the first five days of instruction in the summer session, refund is made of the full amount of the tuition and fees assessed except for a nonrefundable charge of $20.00.[1] When the total assessment has been less than this amount, the full amount of the assessment, if any, is nonrefundable.

(2) After the first five days but within the first half of the summer session, one-half of the amount assessed which remains after deduction of the above mentioned $20.00 is refunded.

(3) After the midpoint of the summer session, no refund is allowed.

A student who reduces his registration to a lower range receives a refund of the full amount of the difference in tuition and fees specified for such schedules provided the changes are made during the period designated for refund of full fees in case of withdrawal from the University. One-half of the above differences is refunded if the changes are made during the period for one-half refund in case of withdrawal from the University. Thereafter, no rebate is allowed.

FINANCIAL AID

Various types of financial assistance are available each year to promising students in all fields of study in the Graduate College. Detailed information about qualifications and application procedures for these awards is given in the brochure, *Financial Aid for Graduate Students*, which may be obtained by writing to the Graduate College or to any of the graduate departments.

The principal kinds of awards are listed below.

Fellowships

University Fellowships. University Fellowships, which are awarded on the basis of an all-University competition, are generally unrestricted

[1] The nonrefundable charge includes the hospital-medical-surgical insurance fee, if originally paid; the student who withdraws from the University continues to be covered by the insurance until the close of the term.

as to the student's field of graduate study and provide stipends of not less than $2,000 for the academic year, or $2,500 for eleven months, with exemption from tuition and all regular fees which are assessed at the time the student registers. A student receiving a University Fellowship may accept, if offered, a part-time teaching or research assistantship to a maximum of one-quarter time. University Fellows must carry a full program—four units or the equivalent.

Fellowships are also provided for teaching assistants for the summer session only. These awards are restricted to graduate students who have held teaching assistantships at the University of Illinois for at least half-time for both semesters of the preceding academic year, who have earned not less than two units of graduate credit during that year, and who have demonstrated superior scholarship. Like regular University Fellows, they are selected on the basis of an all-University competition. The Summer Fellowships carry stipends of $500, for the eight-week summer session, plus tuition and fee exemptions.

In addition to the all-University awards, there are Fellowships in the Creative and Performing Arts. These awards are made primarily on the basis of the applicant's creative achievements and promise rather than on his academic and scholarly qualifications. Students in the fields of dance, theatre, architectural design, landscape architecture, sculpture, painting and printmaking, graphic design, industrial design, and music are eligible. Applicants may contact the appropriate department.

National Defense Graduate Fellowships. National Defense Graduate Fellowships are financed under Title IV of the National Defense Education Act of 1958, and administered with the cooperation of participating universities. This program assists students who are preparing to teach in the nation's colleges and universities. Each fellowship, restricted to citizens or permanent residents of the United States, is for a three-year period to a student beginning his graduate studies. The stipend for the academic year is $2,000 for the first year, $2,200 for the second, and $2,400 for the third, plus an allowance for dependents. Students who attend the summer session following the academic year may receive $400, plus dependency allotment. These fellowships provide exemption from tuition and all regular fees which are assessed at the time the student registers. A holder of a Title IV Fellowship may, under certain conditions, also be appointed as a part-time teaching or research assistant.

Under Title VI (Modern Foreign Languages) of the National Defense Education Act, the University of Illinois participates in programs in Asian, Russian, and in Latin-American Language and Area Studies. These fellowships, restricted to citizens or permanent residents of the United States, are intended for students planning a college or university

teaching career or other career centering on problems of the language area. The stipend for the fellowships, which is renewable, is $2,250 for the academic year, or $2,700 for the summer and academic year, plus an allowance for dependents. Title VI Fellowships also provide for the payment of tuition and fees.

Requests for information and application materials should be directed to the student's prospective department.

Office of Education Fellowships. Fellowships are available in specialized areas of teacher training including Prospective Teacher and Experienced Teacher Programs under the Higher Education Act Title V-C. Prospective Teacher Fellowships are offered to students working toward an advanced degree in elementary or secondary education. Certified teachers presently teaching in elementary or secondary schools are eligible for Experienced Teacher Fellowships. For information, write to the College of Education, 110 Education Building, indicating your particular area of interest.

Industrial, Endowed, Special Fellowships, and Traineeships. Various industrial firms, foundations, government agencies, and private individuals have generously donated funds to support special fellowships for graduate students at the University of Illinois. The stipends and supplemental allowances of these fellowships are not uniform, and most of them are restricted to students in particular areas of study. Brief descriptions of the names, donors, fields, and other conditions pertaining to each are presented in the brochure, *Financial Aid for Graduate Students.*

Traineeships

National Science Foundation Traineeships. Under this program, grants are made directly to the participating institutions, who select promising individuals for full-time graduate study. Appointments may be made only to citizens of the United States (or native residents of a United States possession) who are enrolled in programs leading to an advanced degree in the mathematical, physical, medical, biological, or engineering sciences, anthropology, economics, geography, the history and philosophy of science, linguistics, political science, psychology, and sociology. Also included are interdisciplinary areas which are comprised of overlapping fields among two or more sciences (for example, geochemistry and meteorology).

The basic stipends for twelve months are $2,400 for those at first-year level, $2,600 for those at intermediate-year level, and $2,800 for those at terminal-year level, plus exemption from tuition, service fee,

and hospital-medical-surgical insurance fee. An allowance of $500 is granted for each dependent. Recipients of these awards may elect a nine months' tenure, rather than twelve months, with a corresponding decrease in the stipends and allowances. In addition, traineeship awards may be available for the summer session only.

Inquiries concerning traineeships should be directed to the appropriate department at the University.

National Aeronautics and Space Administration Traineeships. The National Aeronautics and Space Administration sponsors traineeships at the University of Illinois for students who are majoring in the space-related sciences and technology. Awards are made to first-year graduate students and provide an annual tax-free stipend of $3,200 for twelve months, with exemption from tuition and all regular fees that are assessed at the time of registration. Advanced students and students with dependents receive up to $3,400. NASA trainees must carry a full program—four units or the equivalent—and may accept an additional teaching appointment up to one-fourth time. Inquiries concerning this program should be directed to the student's prospective major department.

Public Health Service Traineeships. These appointments are designed to permit graduate students to receive advanced training in certain specialized areas, such as social work, mental health, public health, vocational rehabilitation, and speech correction. A traineeship is virtually equivalent to a fellowship since the stipend is considered a tax-free gratuity and no duties are required other than those directly contributing to the training program. The stipends vary from $1,800 to $2,800 or more depending on the recipient's level of study and area of specialization. Tuition and fees also are ordinarily covered. Inquiries concerning traineeships should be directed to the student's prospective major department.

Assistantships

The various departments of the University employ graduate students as teaching or research assistants. The usual appointment is for half-time service, at a salary of $2,500 for the academic year (September to June). Applications may be made directly to the appropriate department.

Assistants holding appointments ranging from 25 through 67 per cent of full-time service are exempt from the tuition and service fee, but not from the hospital-medical-surgical insurance fee. For more detailed information concerning fee assessment, see pages 28 to 31.

Appointments for part-time assistantships also are available in non-teaching bureaus and agencies. For further information and application materials, write directly to: Bureau of Business Management, Bureau of Economic and Business Research, Center for Instructional Research and Curriculum Evaluation, Institute of Communications Research, Institute of Government and Public Affairs, Institute for Research on Exceptional Children, Physical Environment Unit, and Small Homes Council-Building Research Council. All agencies may be addressed in care of the University of Illinois, Urbana 61801.

Part-time appointments as student residence hall counselors are also available. These provide cash stipends plus room and board and the same exemption from tuition and the service fee accorded other staff members. For further information, students should write to the Residence Staff Adviser, 174 Weston Hall, Champaign, Illinois 61820 or to the Associate Dean of Women, 130 Student Services Building, Champaign, Illinois 61820.

Tuition and Fee Waivers

These awards provide exemption from the tuition and service fee, but not from the hospital-medical-surgical insurance fee, for the academic year and the summer session immediately preceding or following. Students holding these awards must be in residence and must register for at least three units each semester during the academic year. They may, however, accept part-time or incidental employment not to exceed twenty hours a week either within or outside the University.

Veterans who are admissible to a graduate program and who meet certain residence requirements may be eligible for exemption from tuition and certain fees under the state statute concerning Military Scholarships. Further information may be obtained from the Director of the Undergraduate Scholarship Program, 707 South Sixth Street, Champaign, Illinois 61820.

How to Apply

Application materials with instructions may be obtained from the Graduate College or from any graduate department. Only one application form is needed to apply for any of the types of financial aid listed on pages 34 to 38. A specially marked application for the National Defense Education Act Title VI Fellowships may be obtained from Professor C. Ernest Dawn, Chairman of the Committee on National Defense Foreign Language Fellowships, 350 Armory, Champaign, Illinois 61820.

To be considered for a University Fellowship beginning in June or September, the application must be filed with the major department no later than February 15. Applications for tuition and fee waivers and assistantships are accepted after that date, but applicants for such appointments are strongly urged to submit their applications as early as possible since many departments offer assistantships at the same time they consider applications for fellowships. An age limit of thirty-five years applies to applicants for University Fellowships and tuition and fee waivers.

Announcement of Awards

Fellowship awards are announced by the Graduate College on or about April 1. Recipients are expected to accept or decline by April 15.

The University of Illinois adheres to the following resolutions adopted by the members of the Association of American Universities and a number of other graduate schools of North America:

"In every case in which a graduate assistantship, scholarship, or fellowship for the next academic year is offered to an actual or a prospective graduate student, the student, if he indicates his acceptance before April 15, will still have complete freedom to reconsider his acceptance and to accept another fellowship, scholarship, or graduate assistantship. He has committed himself, however, not to resign an appointment after this date unless he is formally released from it."

Loan Funds

Information and application forms concerning loans from the University, the National Defense Education Act, the Illinois Guaranteed Loan Program, the United Student Aid Fund, short-term emergency loans, and other loan funds may be obtained from the Student Loan Office, 707 South Sixth Street, Champaign, Illinois 61820. The amount of the loan which is finally approved by the Committee on Loans is subject to the availability of funds and the financial need of the applicant relative to all other applicants. Priority is given to students with superior academic backgrounds.

University Loans. A student may borrow from the University Loan Fund an amount not to exceed $1,000 per year or a total of $2,500. Loans are repayable, at a minimum of $30 monthly, at an interest rate of 3 per cent annually, beginning four months after leaving the University, with the requirement that all loans be repaid within four years.

National Defense Education Act Loans. Eligible graduate students may request financial assistance from funds provided to the University

under Title II of the National Defense Education Act. The limit is $2,500 per year to a total of $10,000. Repayment begins in monthly installments, at an interest rate of 3 per cent annually, nine months after the borrower has ceased to pursue a fulltime course of study. The entire loan must be repaid within ten years after repayment begins.

Up to 50 per cent of a National Defense Education Act loan is cancelled if the borrower serves as a full-time teacher in a public or nonprofit private school in the United States. This applies to elementary or secondary schools and institutions of higher education. Such cancellation is at the rate of 10 per cent of the loan, for each academic year, or its equivalent, of such service. Also, if teaching service is performed in an elementary or secondary school officially classified as having a high percentage of students from low income families, cancellation is at the rate of 15 per cent per year with no limit on total cancellations.

Illinois Guaranteed Loan Program. A borrower must be a citizen of the United States and a bonafide resident of the state of Illinois. All fifty states are participating in the Guaranteed Loan Program. A non-Illinois resident must seek assistance through the program in his home state.

Graduate students may borrow from a minimum of $300 to a maximum of $1,500 during an academic year while enrolled for full-time study.

No loan is granted in an amount which exceeds the established educational expenses at the eligible college selected by the student, minus other scholarship or loan assistance.

Repayment of principal is required at a minimum monthly rate of $30 beginning nine months after the borrower ceases to be a full-time student, and the loan must be paid in full within six years from the date the borrower was last a full-time student.

The maximum interest rate permitted by law is 6 per cent simple interest, which begins on the date of the loan. If the family of the borrower has an annual "adjusted income" (gross income less taxes and/or other deductions) of less than $15,000, the Federal government pays all of the interest while the borrower is in college and 3 per cent during the repayment period. A student not qualified for Federal interest subsidy is required to pay his own interest on a semi-annual basis while in school.

United Student Aid Fund Loans. A graduate student may apply for assistance up to $1,500 per year to a combined total of $7,500 at the time of graduation. (This total includes loans not in excess of $1,000 a year as an undergraduate student.) The amount of a loan is determined on an individual basis. No notes under this plan may bear more than

6 per cent simple interest. Repayments begin the first day of the fifth month after graduate education is completed. The normal repayment period is thirty-six months, but larger loans may be repaid over periods ranging up to fifty-four months. Monthly installments may not be less than $30.

Short-term Emergency Loans. Short-term emergency loans may be requested by students. The loan must be paid within sixty days, or by the end of the semester, whichever date is earlier. Request forms may be obtained from the Student Loan Office.

Other Loan Funds. The Student Loan Office maintains a list of additional loan sources, such as private foundations, church-related sources, and bank sources. This information will be provided upon request to a student needing financial assistance.

ACADEMIC AND OTHER REGULATIONS

A student should familiarize himself with the academic requirements and regulations of the Graduate College and of the department in which he is working. He is responsible for complying with these regulations and for fulfilling all requirements for his particular degree. Every graduate student should have a Graduate College catalog and, if available, a departmental brochure. The Graduate College calendar included in this catalog is also printed separately and may be obtained from the Graduate College Office, 330 Administration Building.

Petitions

The normal procedures and requirements of the Graduate College are indicated in this catalog. A student may petition to the Dean of the Graduate College for exceptions, but he should so do only after consultation with his adviser. Forms for such petitions may be secured at the Graduate College Office.

Residence

Each degree candidate must spend a certain period of time in "residence." Residence is realized when a student lives in the community, or its immediate surroundings, and devotes an appreciable portion of his time to graduate studies. A student who is regularly employed outside the Urbana-Champaign community is not considered to be in residence even though he is registered in a campus course.

Work Completed Elsewhere

A candidate for the doctorate, who has received a master's degree from a recognized institution, receives the equivalent of eight units of credit for that work. If such credit is to be used in partial fulfillment of the requirements for the doctorate, he is examined on the content of the courses involved at the time of the preliminary examination.

A student who has completed graduate work in a recognized institution, but without receiving a degree, may petition to obtain credit toward an advanced degree by passing examinations in this work. Admission to such examinations requires the approval of the departments concerned and of the Dean of the Graduate College. The acceptance of credit for work completed elsewhere does not reduce the residence requirement for an advanced degree.

Time Limit for Advanced Degrees

A candidate for the master's degree must complete all requirements for the degree within five calendar years after his first registration in the Graduate College.

A candidate for the doctor's degree must complete all requirements for this degree within seven calendar years after his first registration in the Graduate College, except as noted in the following paragraph.

A candidate for the doctorate who has received a master's degree elsewhere must complete all requirements for the degree within five years after his first registration in the Graduate College. A student whose program of study is significantly interrupted after he receives a master's degree from the University of Illinois and who later returns to work for his doctorate will have five years from the date he returns to complete degree requirements.

Advisers

Every graduate student must have an adviser in the department or division in which he is a degree candidate. The adviser's primary duty is to assist in planning a program of graduate work that fits the needs of the student and satisfies departmental and Graduate College requirements. A new student should go to his major department to discuss the selection of an adviser.

Unit Credit for Courses

Graduate credit is measured in terms of units. One unit is considered the equivalent of four semester hours. The normal program for a full-

time graduate student is four units each semester; the maximum permissible is five. The normal program for an eight-week summer term is two units; the maximum permissible is two and one-half units.

Grades

Grades are recorded by letters as follows: for thesis research and noncredit seminars, S and U (satisfactory and unsatisfactory); for courses, A, B, C, D, and E (failure). A student who receives as much as two but *less* than three units of grades below B must replace such units with additional units of A or B grade to qualify for an advanced degree. Three units of grade below B disqualify a student as a degree candidate.

Maximum and Minimum Registration

Students holding University Fellowships or other fellowships awarded by the University must carry a full program (four units or the equivalent). Those awarded tuition and fee waivers must carry a minimum program of three units or the equivalent. The academic work carried by assistants and others on the University staff is limited by statute, and those employed outside the University are expected to reduce their programs of study in accordance with these regulations. The maximum amount of academic work is determined by the terms of employment as follows:

	Maximum Registration	
Terms of Employment	*Semester*	*Summer Session*
Full time	1 unit	1 unit
Three-fourths time	2 units	1¼ units
Two-thirds time	2¼ units	1½ units
One-half time	3 units	1¾ units
One-third time	3¾ units	2 units
One-fourth time	4 units	2 units

Exceptions to the *semester* schedule are possible by means of a special petition procedure. This privilege does not apply to summer session.

Conferring of Degrees

Advanced degrees are conferred in February, June, August, and October, except that the doctorate is not awarded in August. No more than two graduate degrees will be conferred for work completed at the University of Illinois.

THE MASTER'S DEGREE

Master's degrees are offered in the fields indicated on pages 8 and 9. Unless otherwise specified in the departmental listings, the credit requirement for this degree is at least eight units. Three of the eight units must be in courses numbered in the 400 series, and two of these three must be in the major field.

Residence

A candidate must spend at least two semesters, or the equivalent, in residence and must earn at least half the required units while in residence.

Major Requirement

At least four units of work must be in the area of concentration. The remaining credit may be in that field or in other courses appropriate to the student's educational goals.

Thesis

A student electing or required to write a master's thesis should file the subject of the thesis at the Graduate College Office at least six weeks prior to graduation. No more than three units of thesis credit may be included in an eight-unit program. Credit in thesis research can not be applied to a degree unless a thesis is submitted.

For specific instructions regarding the format of the thesis, the student should obtain a copy of the leaflet, *Instructions for Preparation of Theses*, from the Graduate College Office.

Master's Degrees in Teacher Education

Programs leading to master's degrees for teachers are available in the areas listed below and in a number of the departments of the College of Education (see page 145).

Agricultural Education—page 64
Art—page 84
Biological Sciences and General Science—page 243
Chemistry—page 102
Earth Science—page 200
English—page 176
English as a Second Language—page 177
French—page 190
Geography—page 195
German—page 204
Health Education—page 207
Home Economics—page 217

Latin—page 120
Mathematics—page 276
Music—page 297
Physical Education—page 315
Physical Sciences—page 318
Physics—page 318
Russian—page 349
Social Studies—page 353
Spanish—page 364
Speech—page 369
Speech Correction—page 370

Applicants who have not completed requirements of a four-year undergraduate curriculum leading to teacher certification may be admitted to these programs on the approval of the appropriate adviser and the Coordinator of Teacher Education, but they must complete teacher certification requirements, as well as the usual program requirements, in order to qualify for the master's degree in teacher education.

Requirements for Teacher Certification

The requirements for teacher certification, referred to above, are of three kinds. The student must meet general education requirements and teaching field requirements equivalent to those of the appropriate undergraduate curriculum. The determination of this equivalence is ordinarily made by the adviser. The student must also meet the professional education requirements equivalent to those of the undergraduate curriculum. If the student has not fulfilled this requirement (eighteen hours of credit in professional education courses), he may take the courses listed below to satisfy this requirement.

Educational Psychology 211 (or equivalent).....3 semester hours
Elementary Education 231 or Secondary Education 241.....3-5 semester hours
Educational Practice 232 or 242.....5 semester hours
History and Philosophy of Education 304.....½ unit
History and Philosophy of Education 305.....½ unit
Educational Psychology 311.....½ unit
Educational Psychology 312.....½ unit

If the credit in the above list is given in terms of units, it may be assumed that such credit will apply toward requirements for the master's degree as well as the requirements for certification. Educational Psychology 211 is prerequisite to Educational Psychology 311 and 312, and may be waived on the basis of a non-credit proficiency examination administered by the Department of Educational Psychology. A successful proficiency examination, however, does not serve to reduce the eighteen hours of professional education courses required for certification.

Educational Practice 232 or 242, student teaching, is required of all students seeking teacher certification. Students who are on the campus during the spring semester prior to the year in which they expect to enroll in student teaching must apply for an assignment by January of that

year; students who were not on the campus during the spring semester may apply for assignment during the first three weeks of the fall semester. Application forms may be obtained in the Office of Student Teaching, 236 Education Building.

To be considered for admission to student teaching, graduate students must have completed one semester of work on the Urbana campus and be registered in a teacher education program. Registration in student teaching requires concurrent registration in the appropriate section of the specialized course in technics of teaching.

Students pursuing both certification and master's degree requirements should anticipate at least the equivalent of three semesters of full-time study.

THE DEGREE OF THE DOCTOR OF PHILOSOPHY

The degree of Doctor of Philosophy is offered in the fields indicated on pages 8 and 9. General requirements are described below; special requirements are given in departmental listings. For information about doctoral level professional degrees in business administration, education, law, and music, see the appropriate sections.

Residence

A doctoral program includes three stages. At least two of these stages must be completed in residence; the residence period must include two successive semesters in the second or third stage.

The first stage ends when the candidate receives a master's degree or earns the equivalent credit (eight units or thirty-two semester hours); *the second stage* comprises eight units of work, fulfillment of major, minor, and language requirements, and a successful preliminary examination; *the third stage* comprises research and seminars (eight units), preparation of the dissertation, and the final examination.

A student may complete these stages in three years, if full time is devoted. For maximum time allowed, see page 42.

Programs of Study and Areas of Specialization

A student's courses and research are planned with his adviser. Consideration is given to previous academic training, career objective, general regulations of the Graduate College, and any specific departmental requirements. The student should learn and satisfy these regulations and requirements as soon as possible.

The major area of specialization is a closely-related selection of courses; not all are necessarily offered by the major department.

If a student elects or is required to declare a minor outside his major department, the selection must be approved by the department or division concerned. A minor area of specialization is a distinctly-related group of courses; they may be offered in more than one department.

Language Requirements

A candidate for the degree of Doctor of Philosophy must demonstrate a reading proficiency in two languages other than English, or a high degree of proficiency in one language other than English. Although French, German, and Russian are acceptable in all doctoral programs, candidates in some departments may be permitted to substitute other languages. See departmental listings for specific requirements.

A candidate should qualify in at least one of the required foreign languages during the first year of study. The entire language requirement should be satisfied early in the doctoral program, no later than two months before the preliminary examination, or during the term (or summer session) preceding admission to the preliminary examination.

Students may satisfy reading proficiency by (1) a direct examination administered by the language department; (2) receiving an acceptable score on the Educational Testing Service Test in the language; or (3) obtaining grades of A or B in French, German, or Russian 401.

To satisfy the language requirement by exhibiting a high proficiency in one language, a student must pass a written reading proficiency examination and must (1) show ability to discuss his research and to an-answer questions in the language; (2) understand and give a resumé of what the examiner reads to him from material in his field; (3) carry on a conversation on the subject of his background and plans.

Certification of proficiency in foreign languages from other colleges and universities is not accepted by transfer, but scores on the ETS Language Tests taken elsewhere will be accepted and evaluated.

Preliminary Examination

To enter the third stage of a doctoral program (see page 46), a candidate must pass a preliminary examination to test his qualifications for further advanced study and research. The examination may be written, oral, or both, according to departmental requirements. The candidate is certified for admission to the third stage by a committee appointed by the Dean of the Graduate College on the recommendation of the Executive Officer of the major department. To maintain his status as a degree candidate, a student who has passed the preliminary examination must

register each semester until the degree is conferred (see third stage requirements, page 46).

Thesis

The Doctor of Philosophy is primarily a research degree and the candidate must demonstrate his capacity for independent research by the production of an original thesis on a topic within his major field of study. The subject of the thesis must be reported to the doctoral committee and to the Graduate College at the time of the preliminary examination.

Candidates engaged in thesis research may find it desirable or expedient to publish, prior to the conferral of the degree, certain findings that later will be incorporated in the dissertation. In this case appropriate acknowledgement of the earlier publication should be included in the dissertation. The Graduate College encourages such publication, but the thesis in its entirety may not be published before all degree requirements have been completed.

Directions regarding the format of the thesis are given in the leaflet, *Instructions for Preparation of Theses*, which may be obtained in the Graduate College Office. The candidate must submit to the Graduate College, no later than the date specified in the current calendar, (1) the original and the first carbon copy (or two copies reproduced by an approved method) of his thesis, and (2) one typewritten copy of an abstract not exceeding six hundred words.

Each candidate who passes the final examination must pay a $25.00 microfilm fee. This provides for (1) microfilming the complete thesis, with one copy deposited in the University of Illinois Library, and (2) publication of the abstract in *Dissertation Abstracts*.

Final Examination

The candidate is admitted to the final examination by the Dean of the Graduate College upon completion of the dissertation and the recommendation of the major department.

SPECIAL EDUCATIONAL OPPORTUNITIES

Traveling Scholar Program

The University of Illinois is one of eleven midwestern member universities of the Committee on Institutional Cooperation and a participant in the Committee's Traveling Scholar Program. This program enables

an advanced graduate student to work at another campus for a semester in order to take advantage of special course offerings or research facilities, such as a unique laboratory or library collection, not available at his own institution. A CIC Traveling Scholar registers at his home university, and credit for the work is recorded there. Appointment as a Traveling Scholar is based upon the individual submission to the Graduate College of an application which carries the strong endorsement of the student's major department and the approval of the host institution. Each university retains the right to accept or reject any student desiring to study under its auspices. A student interested in participating in the program should consult with the head of his major department.

Auditing Privileges

A graduate student or a person not registered in the University of Illinois is permitted to attend classes (other than laboratory courses) as an auditor, provided a form bearing the approval of the instructor and the Dean of the Graduate College is filed with the Records Office, 69 Administration Building. A student should not enter on his program card any courses which he plans to attend as an auditor.

Extramural Courses

Graduate courses in a few areas of study are offered at various centers throughout the state. A student who is employed full time may not register for more than one unit of extramural course work in any one semester nor more than one unit in any combination of extramural and campus courses.

Because extramural course work is not considered work in residence, credit earned in such courses can be applied toward an advanced degree only if (1) the courses are approved in advance by the adviser and constitute part of a well integrated program, and if (2) the total extramural credit does not exceed two units (the Ed.M. and the Advanced Certificate excepted). Credit earned in extramural courses can not be applied toward the second stage of a doctoral program (see page 46).

Correspondence Courses

Credit earned in correspondence courses can not be applied toward an advanced degree. However, it is possible to fulfill certain prerequisites or remove deficiences through correspondence work. A catalog of correspondence courses offered by the University of Illinois may be obtained from the Division of University Extension, Correspondence Courses, 104 Illini Hall.

Fields of Instruction

Courses open to graduate students are of two types. Those numbered from 300 to 399 are open to advanced undergraduate and graduate students. Those numbered 400 and above are open to graduate students only. Those numbered 500 to 599 are open only to graduate students in certain professional programs.

All courses for graduate students require previous preparation. By consultation with the instructor, a student may determine whether he has had the necessary prerequisites for a particular course.

Courses in this catalog are listed alphabetically by departments. The offerings in each field are arranged numerically in groups, with headings to indicate the students for whom they are designed. The 400 series are listed first; courses in the 300 series follow. After the title of each course is a brief description of its contents, the credit given, and the requirements for admission to the course.

A number of courses offer variable credit. At the 300 level, additional work in the nature of special reports, papers, or projects is required of a student who registers for the maximum credit shown. In each case, the student, with help of his adviser, determines whether or not his schedule allows sufficient time to complete the work required for maximum credit.

At the 400 level, research, reading, and independent study courses provide variable credit; proportionate time devoted to a particular activity can thus be indicated on the student's record.

Unless otherwise specified, it can be assumed that a course is offered at least once during each calendar year. Courses offered only in the summer session are indicated by "S"; courses given in alternate years are indicated with the year of offering. A complete listing of courses for each term is contained in the Time Table, published about six weeks prior to the beginning of each term and available from the Graduate College, 330 Administration Building.

ACCOUNTANCY

The Department of Accountancy offers graduate work leading to the Master of Science and Doctor of Philosophy in Accountancy and to the Master of Accounting Science (M.A.S.). For graduates of business schools with credit in appropriate undergraduate courses, the M.A.S. degree requirements can be completed in one year. For non-business graduates, the M.A.S. can be earned in two years.

The grade-point average required for admission to graduate study in accountancy is 4.0. Applications from students with a grade-point average between 3.75 and 4.0 are considered on an individual basis. All applicants, native or foreign, are required to take the Admission Test for Graduate Study in Business. This test should be taken early enough to insure that the results will be available to the department prior to action on admission. All applicants except those applying for the M.A.S. program for non-business graduates should have the equivalent of the undergraduate curriculum at the University of Illinois, including twenty hours of undergraduate work in accountancy (twenty-four hours for M.A.S. candidates), courses in economic theory and the functional areas of business, two courses in statistics, and courses in finite mathematics and calculus. Students may take graduate-level courses to satisfy entrance requirements for which they receive elective credit. In addition, applicants must take or have credit (graduate or undergraduate) in linear algebra, operations research, and a course in or knowledge of computer programming and applications.

All graduate students in the Department of Accountancy are required to take Accountancy 481, Concepts and Principles, and Accountancy 483, Income Determination. Candidates for the Master of Accounting Science program are also required to take Accountancy 594, Methods and Practices in Professional Research.

Master of Science. Eight units of graduate work, of which at least six must be at the 400 level, are required for the Master of Science degree. A candidate must have at least five units in accountancy, two of which are earned by the satisfactory completion of a master's thesis. The remaining three units may be taken in accountancy or in other fields, including one or more minors, subject to the approval of the graduate adviser.

Master of Accounting Science (professional degree). This program is designed for candidates who wish to prepare for professional careers in public, governmental, or industrial accounting, as well as those who plan to continue toward the doctorate and a career in university teaching and research.

Candidates qualifying for the one-year M.A.S. degree must complete eight units of graduate credit. Four of the eight units are required to be taken in accountancy courses, including Accountancy 481, 483, and 594. In addition, one graduate-level course in both economic theory and organizational theory are required. No thesis is required. A graduate adviser assists each student in complying with the program requirements as well as the selection of electives.

For non-business graduate students, the department offers a two-year M.A.S. program. During the first year, the student normally takes Accountancy 501, 502, 503, and 504. Depending upon his background, he also enrolls in courses in statistics, business economics, operations research, business organization, and decision theory. In his second year, he satisfies the requirements of the one-year M.A.S. program outlined above. Adequate provisions have been made for electives suited to the particular interests of the student subject to the approval of his adviser.

Students who believe they already meet some of the requirements of the two-year M.A.S. program are given the opportunity to substitute elective courses for areas in which they can satisfactorily demonstrate their proficiency. In all, sixteen units of graduate work are required to complete the two-year program.

Doctor of Philosophy. A candidate for the Doctor of Philosophy degree is required to satisfy the prerequisites for graduate study in accountancy, stated above,

and have his admission approved by the departmental admissions committee which may require an oral or written examination.

The requirements for the Doctor of Philosophy degree include a master's degree, credit in micro- and macro-economics, a minor or minors of at least four units in fields other than accountancy, at least eight units in accountancy (including not less than six units taken for graduate credit at the University of Illinois), and additional units to bring the total to at least twenty-four, including the eight units allowed for a master's degree. Eight of the twenty-four must be doctoral dissertation units. The doctoral program of each student, including the selection of an appropriate minor or minors, is subject to the approval of the graduate adviser.

The candidate is required to pass examinations in two foreign languages, an oral and written preliminary examination prior to dissertation research, and an oral final examination on his doctoral dissertation. In his preliminary examination the candidate must demonstrate a thorough knowledge of accounting theory and of the areas of accountancy in which he specialized, a general acquaintance with the subject matter and bibliography of other areas of accountancy, and proficiency in his minor fields.

Requests for further information about any of the programs described above should be addressed to the head of the department, 360 Commerce and Business Administration Building (West).

GRADUATE FACULTY

Professors: E. J. DeMaris (Head of Department), N. M. Bedford, R. I. Dickey, C. F. Dunham, H. P. Holzer, Dorothy Litherland, G. E. Lukas, R. K. Mautz, C. A. Moyer, K. W. Perry, D. H. Skadden, W. E. Thomas, N. D. Wakefield, V. K. Zimmerman.

Associate Professors: G. D. Brighton, P. E. Fess, H. M. Schonfeld, C. Weber.

Assistant Professor: J. W. Deskins.

PROFESSIONAL COURSES

501. Accounting Analysis, I. Uses of accounting information; collection, processing, and communication of accounting information; measurement of assets, liabilities, equities, and income; accounting system design. ¾ unit. Deskins.

502. Accounting Analysis, II. An in-depth study of accounting valuation processes and accounting income measurement; special reporting problems of multiple-entity organizations; accounting for nonprofit organizations. ¾ unit. Prerequisite: Accountancy 501 or equivalent. Bedford.

503. Managerial Accounting. Introduction to management accounting as a part of a firm's information system, in terms of modern cost accounting and budgetary systems for planning and controlling business operations. 1 unit. Prerequisite: Credit or registration in Accountancy 501 or equivalent. Holzer.

504. Taxation and Auditing. Introduction to historical and conceptual material in specialized accounting areas of taxation and auditing. Emphasis centered on provisions of the tax law relevant to accounting measurement methods and on nature of evidence in auditing, auditing standards and techniques, and ethical constraints imposed on the auditor. 1 unit. Prerequisite: Accountancy 501, 503, or equivalent. Brighton.

566. Accounting Problems of Industrial Management. A development of the role and importance of cost and revenue data in the process of enterprise administration. Attention is focused on the goals of the firm and the possible aid in achieving these goals that would come from properly conceived, prepared, and utilized

cost and revenue data. For Master of Accounting Science and Master of Business Administration students only. 1 unit. SCHONFELD.

577. **Professional Problems.** Instruction as to types and methods of solution of professional problems in public accounting, including practice in analyzing and solving a wide variety of such problems. For Master of Accounting Science students only. 1 unit. PERRY, SKADDEN.

594. **Methods and Practices in Professional Research.** Instruction in research methods, materials, and techniques together with individual practice in conducting and reporting on specific professional research projects. For Master of Accounting Science students only. 1 unit. DESKINS, ZIMMERMAN.

COURSES FOR GRADUATES

432. **Accounting Under Different Social Systems.** An inquiry into the ways accounting has been adapted to the needs of different social systems; the extent of its contribution; its apparent limitations. Consideration is also given to the relationship between accounting and the growth and development of social systems. 1 unit. Prerequisite: Consent of instructor. DEMARIS.

441. **State and Federal Accounting Theory.** Advanced study in accounting and other fiscal procedures of the federal government; state, county, and municipal governments; institutions. 1 unit. LUKAS.

455. **Macro-Accounting.** Same as Economics 425. An examination of the fundamental concepts underlying the attempts to measure the economic activities of macro-units; similarities and contrasts of accounting problems, theoretical and practical, of the business enterprise and of national or regional units in relationship to existing systems of accounting measurement; macro-accounting statements and analyses; usefulness of macro-accounting techniques and data in evaluating national and regional goals. 1 unit. Prerequisite: Intermediate macro-accounting theory or consent of instructor. ZIMMERMAN.

461. **Administrative Accounting.** Accounting as a tool for management; organization of accounting department, coordination of departmental operations, control of assets, control of operations, management audits, accounting aspects of coordinating the business with market conditions, cooperation with public accountants and government agencies, and social responsibilities. 1 unit. HOLZER, THOMAS.

466. **Cost Accounting Theory and Analysis.** A critical examination of cost accounting methods as to truth and expediency. 1 unit. DICKEY, HOLZER.

471. **Accounting Reports.** Form, contents, certificates, comments, consolidated statements, auditor's rights and responsibilities, published corporation reports. 1 unit. WAKEFIELD.

472. **Auditing Standards and Techniques.** A critical analysis of the techniques used in auditing; interrelation of audit standards, procedures, principles, and techniques; internal control as related to audit techniques; trends and developments in the accounting profession. 1 unit. MAUTZ, MOYER.

473. **The Theory of Accounting System Design.** Problems and procedures in connection with designing and installing accounting systems. 1 unit. THOMAS.

474. **Income Tax Development.** A theoretical and historical approach to the study of the development of federal income taxation, together with some research on tax cases and critical appraisal of the current law and proposals for its revision. 1 unit. BRIGHTON, SKADDEN.

475. **Accounting Information System Simulation.** An examination of the concepts and methodology of simulation, with particular emphasis on the information

system of the firm. A simulation model is developed and used as a basis for deriving information regarding system performance. 1 unit. Prerequisite: Mathematics through calculus, knowledge of computer programming, or consent of instructor.

481. Concepts and Principles. The fundamental structure of accounting theory is developed through the study of concepts characteristic of accounting and an examination of the literature dealing with the concise formulation of accounting principles. 1 unit. BEDFORD, MAUTZ, MOYER.

483. Income Determination. A study of the pros and cons of various unsettled issues involved in the calculation and disclosure of enterprise periodic income. 1 unit. BEDFORD, MAUTZ.

485. Relationship of Accounting Theory to Philosophy, Science, and Other Disciplines. An examination of the relationship of accounting theory to the developments, thoughts, and methods in the fundamental intellectual disciplines. 1 unit. BEDFORD.

489. History of Accounting Theory. An examination of the more important aspects of accounting theory under the impact of changing conditions over four centuries, with major emphasis on the later developments. 1 unit. ZIMMERMAN.

493. Special Research Problems. Individual investigations or research projects selected by the students, subject to approval by the graduate adviser and the executive officer of the department. ¼ to 2 units. STAFF.

499. Thesis Research. Individual direction and guidance in writing theses, and seminar discussions of progress made. 0 to 4 units. DICKEY.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. Advanced Accounting. Reserves, sinking funds, actuarial methods, investments, partnerships, statements for special purposes, receiverships, consolidated balance sheets, foreign exchange. ¾ unit. Prerequisite: Accountancy 106 or 166, and 108; an average of C or better in preceding courses in accountancy. BRIGHTON, DUNHAM, LUKAS, WAKEFIELD.

325. Accounting System Design. An introduction to the fundamentals of accounting system design. This includes the design and use of business papers, records, and reports; the functions of business machines in accounting systems; and personnel problems in accounting system design. ¾ unit. Prerequisite: Accountancy 308.

341. Governmental Accounting. Accounts of institutions, municipalities, and state and federal governments; organization; procedure, budget, accounts and records, reports, audits. ½ unit. Prerequisite: Accountancy 108. BRIGHTON, DUNHAM, LUKAS.

362. Business Budgets and Accounting Control. Procedures used in the preparation of business budgets and the principles underlying these procedures. A complete budget is prepared by the student for a typical manufacturing company. ¾ unit. Prerequisite: Accountancy 108. HOLZER, SCHONFELD, THOMAS.

366. Advanced Cost Accounting. Advanced accounting for production management. Principles and methods of accounting for managerial control of costs of production through the use of standards. ½ unit. Prerequisite: Nine hours of accountancy, including Accountancy 106. DICKEY, HOLZER, WEBER.

371. Auditing. Nature of audit evidence, basic audit techniques, audit practices and procedures, professional ethics, audit reports. ¾ unit. Prerequisite: Accountancy 308. FESS, MAUTZ, WAKEFIELD.

372. Auditing Problems and Cases. Application of auditing principles in verification of financial statements; preparation of reports; case studies applicable to specific

industries; current trends. ¾ unit. Prerequisite: Accountancy 371. Fess, Moyer, Zimmerman.

374. **Advanced Income Tax Problems.** Practical and theoretical training in the more common and important provisions of the federal income tax, advanced problems, tax case research and preparation. ¾ unit. Prerequisite: Accountancy 274 and 308. Brighton, Skadden.

377. **Advanced Problems.** Consolidated statements, foreign subsidiaries, insurance, estates, theory, general statements. 1 unit. Prerequisite: Credit or registration in Accountancy 371. Fess, Lukas, Perry.

378. **Advanced Theory and Practice.** Selected problems from C.P.A. examinations: analysis and revision of statements, partnerships, corporations, quasi-reorganizations, mergers, and others; theory auditing, ethics. 1 unit. Prerequisite: Accountancy 377. Perry, Skadden.

ADVERTISING

The Department of Advertising offers graduate work leading to the Master of Science in Advertising. For the program leading to the Doctor of Philosophy in Communications, see page 124.

Admission to graduate study in advertising requires completion of the requirements for a bachelor's degree in an institution of recognized standing. Furthermore, a grade-point average of at least 4.0 is normally required. Applications of students with grade-point averages below 4.0 are considered on an individual basis. All applicants are urged to take the Graduate Record Examination (GRE).

Master of Science. Requirements for this degree include:

(1) A minimum of eight units (with thesis) or nine units (without thesis).

(2) Four units of advertising, or three units and one additional unit approved by the adviser. Candidates must select at least three units from Advertising 481, 482, 483, or 484. Advertising 381, 382, 383, 384, and 387, or the equivalent, also must be included.

(3) A minimum of two units of non-advertising courses.

(4) A thesis of one unit (in exceptional cases two units may be allowed); or in lieu of a thesis a minimum of nine units of course work.

(5) A minimum of four units of credit at the 400 level. Advertising 490 may be included in these four units.

GRADUATE FACULTY

Professors: S. W. Dunn (Head of Department), N. Wedding.

Associate Professors: A. M. Barban, H. W. Sargent.

COURSES FOR GRADUATES

481. **Advanced Advertising Principles.** Same as Communications 481. Emphasis is placed on determination and understanding of the principles as related to the science, philosophy, and art of advertising. Students may not receive graduate credit for both Advertising 481 and 388. 1 unit. Wedding.

482. **Research Methods in Advertising and Communications.** Same as Communications 482. A treatment of basic research concepts and procedures in the social sciences with emphasis on advertising and communications. Both nonquantitative and quantitative methods are examined. 1 unit. Dunn, Pyszka.

483. **Advertising and the Mass Media.** Same as Communications 483. Functions of mass media as carriers of advertising messages; quantitative and qualitative au-

dience research and analysis; formulation of media plans to achieve specific communications objectives. 1 unit.

484. **Advertising and Consumer Behavior.** An examination of consumer behavior as a means of shaping the communications message; use of the behavioral sciences in creative communication strategy. 1 unit. BARBAN.

490. **Special Topics in Advertising.** ½ or 1 unit. Prerequisite: Consent of head of department. STAFF.

499. **Thesis Research.** 1 to 2 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

309. **Public Relations.** Publicity methods and public relations; representation of business and other sponsors to the public and representation of the public to employers. Preparation of public relations units for the press and other media. ½ unit.

381. **Advertising Research Methods.** Quantitative techniques and research methodology in advertising; philosophy of science, statistical methods, survey and experimental design, etc. Emphasis is on the problems of advertising research. ½ unit. Prerequisite: Advertising 281. PYSZKA.

382. **Advertising Creative Strategy.** Theory and practice of advertising message planning and creation for print and broadcast media; use of consumer and market surveys, copy-testing methods, and advertising readership studies. ½ unit. Prerequisite: Advertising 281. SARGENT.

383. **Advertising Media Policy and Strategy.** Analysis of the various advertising media in terms of markets served and factors to consider in the selection of media. ½ unit. Prerequisite: Advertising 281. BARBAN, PYSZKA.

384. **Advertising Campaigns.** Planning and execution of an advertising campaign; market and consumer research; development and allocation of advertising budget, organization and functions of advertising agency, choice of advertising appeals; selection of media; preparation of advertisements—copy and layout. ½ unit. Prerequisite: Advertising 382 and 383, or consent of instructor.

387. **Advertising and Promotion Management.** Analysis of actual advertising situations and study of how such situations were or might have been met. Emphasis is given to management decision-making problems at the national level. ½ unit. Prerequisite: Advertising 281. WEDDING.

388. **Advertising in Contemporary Society.** A study of advertising as an institution and its role in communications, society, our economy, and business. Students may not receive graduate credit for both Advertising 388 and 481. ½ unit. Prerequisite: Advertising 281. SARGENT.

389. **International Advertising and Promotion.** The role of advertising and promotion in international communication and economic development; behavioral science approach to international communications strategy; comparative analysis of advertising and promotion systems. ½ unit. Prerequisite: Advertising 281. DUNN.

390. **Advanced Creative Strategy.** Advanced work in application of behavioral sciences and creative process to planning and writing of advertisements. ½ unit. Prerequisite: Advertising 382 or consent of instructor.

AERONAUTICAL AND ASTRONAUTICAL ENGINEERING

The Department of Aeronautical and Astronautical Engineering offers graduate programs leading to the Master of Science and Doctor of Philosophy. Study and re-

search are planned to prepare graduates for fundamental and applied work in airplane, missile, and space flight engineering. Typical areas of concentration are aerodynamics, aeroelasticity, astrodynamics, propulsion, structural mechanics, and guidance and control.

The minimum grade-point average for admission to graduate study in aeronautical and astronautical engineering is 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

The prerequisite for graduate study in aeronautical and astronautical engineering normally is the equivalent of the undergraduate courses required at the University of Illinois for a bachelor's degree in aeronautical and astronautical engineering; however, graduates of curricula leading to degrees in other fields of engineering, the physical sciences, or mathematics may also be admitted to advanced study.

Candidates for the degree of Master of Science are required to have a minimum of eight units of graduate work, including a thesis.

Because of the wide range of interests in the field of aeronautical and astronautical engineering, there are no specific course requirements for a major in the program of study leading to the degree of Doctor of Philosophy. Each student plans his study program in consultation with a departmental adviser. Courses offered by departments other than aeronautical and astronautical engineering may be included in the major area of study when these courses are of particular value to the work which students desire to emphasize. The major and minor programs must meet with the approval of the head of the department.

Graduate students who desire to minor in aeronautical and astronautical engineering must have taken mathematics through the first course in differential equations and the undergraduate aeronautical and astronautical engineering courses, or their equivalents, which are prerequisites to study in the area of the minor work. Deviation from these requirements requires approval from the head of the department.

For information concerning applied mathematics, see page 285.

GRADUATE FACULTY

Professors: H. S. Stillwell (Head of Department), B. L. Hicks, H. H. Hilton, H. W. Knoebel, Y. K. M. Lin, R. W. McCloy, A. I. Ormsbee, R. A. Strehlow, S. M. Yen.

Associate Professors: H. O. Barthel, C. E. Bond, A. R. Zak.

Assistant Professor: L. H. Sentman.

COURSES FOR GRADUATES

411. Advanced Aerodynamics of Compressible Fluids. Advanced aerodynamic theory of compressible fluids in the subsonic and supersonic velocity ranges. 1 unit. Ormsbee.

414. Boundary Layer Theory. Theories of the boundary layer of a compressible fluid and their solutions, laminar and turbulent; boundary layer in hypersonic flow. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 216 and 232, or equivalent. Yen.

415. Wing Theory. Theoretical analysis of the aerodynamic characteristics of two- and three-dimensional wings and multiple body systems in subsonic and supersonic flow. 1 unit. Prerequisite: Mathematics 346 or equivalent. Ormsbee.

416. Hypersonic Aerodynamics. Discussion of high Mach number flows including the aerodynamic effects of dissociation and ionization. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 411. Ormbsee.

417. Fundamentals of Gas Kinetics. Fundamental concepts required to study gas theory: derivation of the Boltzmann equation from classical mechanics; reduced

and truncated distribution functions and the BBGKY hierarchy; molecular collisions; flux vectors, equations of change; moment equations; summational invariants; H-theorem and Maxwellian distribution; inclusion of the effect of solid surfaces in kinetic theory; existence theory for the Boltzmann equation; iteration procedures; moment methods; Chapman-Enskog procedure; first and second approximations to the distribution function, the heat flux vector, and stress tensor. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 213. SENTMAN.

418. Theory of Rarefied Gas Flows. Application of kinetic theory to rarefied gas flow problems; free-molecule flow; near free-molecule flow; linearized problems; flows with appreciable deviation from equilibrium. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 417 or Physics 362. YEN.

428. Theory of Large Deformations in Nonlinear Continuous Media. Fundamental concepts of large deformations in nonlinear elasticity and inelasticity with applications: generalized tensors, finite deformations, stress-strain relations in terms of strain energy functions, solutions of tension, shear and bending problems, finite plane strain, theory of successive approximations, fiber reinforced beams, plates and cylinders, thermodynamics of deformable media, stability considerations, constituent relations for inelasticity. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 326 or equivalent. HILTON.

429. Theory of Linear and Nonlinear Viscoelasticity. Fundamental concepts of viscoelasticity with applications. Elastic-viscoelastic analogies, creep and relaxation functions, thermo-mechanical reciprocity relations, variational principles, model fitting, shear center motion, thick-walled cylinders under pressure and inertia loads with material annihilation, sandwich plates, propagation of viscoelastic waves, vibration of bars, plates and shells, nonlinear elastic-viscoelastic analogy, properties of nonlinear viscoelastic stress-strain laws, creep rupture, torsion of nonlinear bars and shells. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 326 or consent of instructor. HILTON.

434. Aerodynamic Heating. Theory of convective aerodynamic heating in high-speed flow, laminar and turbulent flows; ablation, transpiration cooling, and mass transfer cooling; aerodynamic heating in hypersonic flow, real gas effects, effect of pressure interactions and vorticity interactions; heat transfer in rarefied gas flows. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 414 or equivalent. YEN.

438. Fundamentals of Combustion. Same as Mechanical Engineering 403. Fundamentals of kinetic theory, transport phenomena, chemical equilibria, and reaction kinetics; flames, their gross properties, structure, and gas dynamics including oscillatory and turbulent burning; solid and liquid propellant combustion; one-dimensional detonation theory including structure and initiation; three-dimensional and other complex detonation waves; supersonic burning. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 216 or Mechanical Engineering 305. STREHLOW.

452. Stochastic Structural Dynamics. Linear structural dynamics problems treated from a probabilistic point of view; axiomatic probability theory and random processes; the response of linear structures to random excitation; practical problems in aeronautical and astronautical engineering. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 250, Theoretical and Applied Mechanics 412, or equivalent. LIN.

453. Stochastic Processes in Engineering. Same as Electrical Engineering 438. This course supplements Aeronautical and Astronautical Engineering 452 or Electrical Engineering 434 for additional engineering applications of stochastic processes. Theories of random pulses and continuous Markov processes and their applications to dynamic and control systems; parametric excitations and stability;

nonlinear devices; topics related to system failures. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 452, Electrical Engineering 434, or equivalent. LIN.

490. Seminar. Presentation by graduate students and staff of current topics in the fields of aeronautics. No credit. Prerequisite: Graduate standing in aeronautical and astronautical engineering. SENTMAN.

493. Special Problems. Theoretical and experimental investigations of problems in airplane, missile, and space flight engineering. 1 to 2 units. STAFF.

499. Thesis Research. Research in the various areas of the aeronautical and astronautical sciences. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

306. Foundations of Mechanics and Gravitational Theory. Same as Astronomy 306. Introduction to the dynamics of particles and of rigid bodies with special emphasis on elementary planetary motion, motion of a rocket, motion of long-range projectile relative to Earth, precession of Earth's axis, etc. 1 unit. Prerequisite: Mathematics 142 or 143. MCVITTIE, STILLWELL.

317. Elements of Magnetohydrodynamics. Same as Astronomy 317. Equations of magnetohydrodynamics, single-fluid and multiple-fluid models, magnetic interaction parameters, magnetosonic waves, hydromagnetic shock waves, aligned-field and cross-field flows, theory of characteristics, MHD acceleration, generation, and propulsion. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 213 and 216 or consent of instructor. BOND.

326. Theory of Continuous Media. Introduction to the general theory of continuous media and its application to the theories of elasticity, fluid mechanics, and inelasticity. Stress and strain tensors and their invariants; nonlinear strain relations; nonlinear equilibrium conditions; the mechanism of deformation of single crystal and polycrystalline media; basic concepts of the structure of matter; thermodynamic considerations; equations of state and stress-strain relationships with applications. 1 unit. Prerequisite: Consent of instructor. HILTON.

327. Thermal Stresses and Creep Buckling. Structural effects of aerodynamic heating; analysis of thermal stresses in elastic, viscoelastic, and plastic media; effect of temperature dependent material properties on thermal stresses; analytical studies of creep buckling due to axial loads and heating of plastic and linear and nonlinear viscoelastic columns, plates, and shells; life expectancy of structures under elevated temperatures; minimum weight and probability of failure; applications to high-speed airplane, missile, and space vehicle structures. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 326 or consent of instructor. HILTON, ZAK.

334. Rocket Propulsion and Rocketry. The basic principles of rocket propulsion and rocketry are treated. Propellants and their influence on design of rockets, internal and external ballistics, combustion processes, design of components, guidance problems, flight performance, and rocket testing are discussed in detail. ½ unit. Prerequisite: First course in thermodynamics or consent of instructor. MCCLOY.

351. Aeroelasticity and Aeroinelasticity. Advanced fundamental treatment of aerodynamic and dynamic structural phenomena associated with flexible airplanes and missiles; divergence of linear and nonlinear elastic lifting surfaces; effect of elastic and inelastic deformations on lift distributions and stability; elastic flutter of straight and swept wings; equations of disturbed motion of elastic and inelastic aircraft; dynamic response to forces, gusts, and continuous atmospheric turbulence; creep divergence of lifting surfaces; flutter in the presence of creep; effect

of temperature on inelastic divergence and flutter. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 250 or consent of instructor. ZAK.

391. Special Problems. Special problems relating to the theory, design, testing, operation, maintenance, or production of airframes or aircraft power plants. ½ or 1 unit. Prerequisite: Consent of instructor. STAFF.

AGRICULTURAL ECONOMICS

(Including Rural Sociology)

Graduate students may take work in agricultural economics leading to the Master of Science and Doctor of Philosophy. Fields of specialization include farm management, land economics, agricultural prices and marketing, agricultural finance, agricultural policy, international economic development, consumption economics, agricultural law, and rural sociology.

Students who desire to secure degrees in agricultural economics must have completed either (1) a course of study equivalent to that required for the Bachelor of Science in Agriculture at the University of Illinois, including twelve hours of agricultural economics and economics, or (2) twelve hours of undergraduate economics and agricultural economics, and at least twelve hours in social sciences (excluding economics), mathematics, and commerce.

Students who desire to specialize in rural sociology should have had a minimum of six hours of sociology.

The grade-point average required for admission to graduate study in agricultural economics is 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

A candidate for the Master of Science degree is required to register for at least two units of economics, including one unit of economic theory. For the Doctor of Philosophy degree, a candidate must complete a minimum of (1) three units in economics, including one unit each of micro and macro theory, both at the 400 level; (2) one 300- or 400-level course in each of two areas in agricultural economics in which preliminary examinations are not written; and (3) two and one-half units in quantitative methods and research methodology. Equivalent courses are accepted in fulfillment of these requirements, subject to Graduate College regulations.

If approved by the Department of Agricultural Economics and the Dean of the Graduate College, the required work in economics may be treated as a part of the major field. Otherwise, the work in economics is considered a first minor, in which case the program in that minor requires the approval of the Department of Economics.

To take agricultural economics as a minor, the student must have had at least twenty hours of undergraduate work in economics and agricultural subjects.

GRADUATE FACULTY

Professors: H. G. HALCROW (Head of Department), C. B. BAKER, R. W. BARTLETT, G. K. BRINEGAR, E. E. BROADBENT, B. L. BROOKS, W. D. BUDDEMEIER, F. DOVRING, F. C. FLIEGEL, C. L. FOLSE, H. W. HANNAH, T. A. HIERONYMUS, J. M. HOLCOMB, J. A. HOPKIN, G. G. JUDGE, R. A. KELLY, N. G. P. KRAUSZ, R. J. MUTTI, F. J. REISS, R. G. SPITZE, E. R. SWANSON, W. N. THOMPSON, R. N. VAN ARSDALL, V. I. WEST, S. W. WILLIAMS, J. E. WILLS.

Associate Professors: L. P. FETTIG, J. H. HERBST, L. D. HILL, M. B. KIRTLEY, A. G. MUELLER, J. R. ROUSH, S. C. SCHMIDT, H. J. SCHWEITZER, J. T. SCOTT, D. G. SMITH.

Assistant Professors: J. W. GRUEBELE.

Agricultural Economics

COURSES FOR GRADUATES

401. **International Comparative Agriculture.** Agricultural and food problems of the world and of selected countries viewed in the world setting; resources and institutional factors affecting production; national and international policies and plans for developing agricultural production and improving levels of living. Emphasis is given to a comparative approach to agricultural development of countries on different economic levels. 1 unit. DOVRING.

404. **Economics of Agricultural Production.** Evaluation of efficiency in the use of agricultural resources; production relationships within the farm; adaptation of the farm business to uncertainty; production relationships among farms; location of agricultural production. 1 unit. Prerequisite: Economics 200 or 300 and Agricultural Economics 341 or consent of instructor. SWANSON.

405. **Economic Policies and Programs Affecting Agriculture.** Economic analysis of state, national, and international policies and programs, including proposed legislation having important bearing on the well-being of farm people. 1 unit. Prerequisite: One semester of graduate work or consent of instructor. HALCROW, SCHMIDT.

406. **Research Methodology in Agricultural Economics.** Methods of inquiry leading to information which is reliable and relevant to the solution of problems significant in the agricultural economy. 1 unit. Prerequisite: Economics 400 or 401, or a course of comparable level in the basic field related to the student's research. BAKER.

425. **Farm Management Principles.** Analysis of farm business records; evaluation of measures of efficiency; planning the cropping system for increased income and control of erosion; use of economic information in fitting livestock to the farm plan; efficient use of labor and power; special research problems in farm organization. Field trip; estimated expense, $8.00. 1 unit. WILLS.

436. **Problems in Marketing Agricultural Products.** Factors influencing growth of markets; methods of reducing costs and improving marketing processes; activities of government agencies; cooperative efforts. 1 unit. BRINEGAR, HILL.

441. **Agricultural Statistics.** Sources and methods of collection and analysis of prices and other agricultural statistics; trend fitting, linear and curvilinear multiple correlation, analysis of variance and sampling. 1 unit. Prerequisite: An elementary course in statistics. WEST.

442. **Quantitative Analysis in Agricultural Economics.** Application of techniques of quantitative analysis in agricultural economics; construction, estimation, and interpretation of sector, spatial, and input-output models for the agricultural economy. 1 unit. Prerequisite: Agricultural Economics 441, Economics 401, and Mathematics 315. JUDGE.

470. **Seminar in Family and Consumption Economics.** Same as Home Economics 470. Discussion of current topics and review of the literature in family and consumption economics. ½ or 1 unit. Prerequisite: Economics 102 or 108 and a course in statistics; Agricultural Economics 370 or consent of instructor. DUNSING.

491. **Seminar and Special Topics.** Each graduate student majoring in agricultural economics must register for this course. Only students who register for credit and complete special studies under the direction of one or more staff members receive credit. 0 to 2 units.

499. **Thesis Research.** Individual research under supervision of members of the graduate teaching staff in their respective fields. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Economics of Agricultural Development. The economics of agriculture and the relationships between agriculture and other sectors of the economy in developing nations; agricultural productivity and levels of living in the less developed areas of the world; studies of agricultural development in different world regions, including Africa, Asia, and Latin America. ¾ or 1 unit. Prerequisite: Economics 103 or 108. THOMPSON.

302. Financing Agriculture. Capital and credit needs of farmers; agencies supplying credit; problems of borrowers and lenders. ¾ or 1 unit. Prerequisite: Economics 102 or 103, or 108. BAKER, HOPKIN.

303. Agricultural Law. Relation of common law principles and statutory law to land tenure, farm tenancy, farm labor, farm management, taxation, and other problems involving agriculture. ½ to 1 unit. HANNAH, KRAUSZ.

305. Agricultural Policies and Programs. The problems of agriculture as an industry and an analysis of past and current federal and state governmental policies and programs affecting agriculture; objectives and development of policies; the use of economic concepts in evaluating possible future agricultural policies and programs; and forces in policy formation. Field trip; expense, $7.00. ¾ or 1 unit. Prerequisite: Economics 108. GRUEBELE, SCHMIDT, SPITZE.

312. Farm Appraisals. Same as Agronomy 312. Valuation methods and value bases of farm real estate. Includes legal aspects of appraisal work, appraisal theory and procedures, condemnation appraisal, characteristics of the farmland market, engineering and agronomic data for farm appraisals, and practice appraisals. Seven field trips; expense about $7.00. 1 unit. Prerequisite: Agronomy 101 and Agricultural Economics 220, or equivalent. REISS, STAFF.

318. Land Economics. Physical, economic, and institutional factors that affect the role of land in economic life; population and resource requirements; principles of land utilization; returns from land; land value; property rights and tenure rights; social controls; rural and urban land development. ¾ or 1 unit. Prerequisite: Consent of instructor. DOVRING.

324. Farm Operation. Operating costs in farming, analysis of farm jobs, farm work simplification, selecting power units and equipment for economical operation. Field trips; estimated expense, $5.00 ¾ or 1 unit. Prerequisite: Agricultural Economics 220. VAN ARSDALL, WILLS.

325. Advanced Farm Management. The functions of management; effects of goals and values on management decisions; use of economic analysis in farm production planning including resource allocation and valuation, and cost minimization. ¾ or 1 unit. Prerequisite: Agricultural Economics 220. SCOTT.

326. Professional Farm Management. Principles of farm management applied to the problems of those managing farms for others as a profession; development of the profession; relationships with clients and farm operators; division of inputs and returns between owner and operator; direct operation of farms with hired labor; case problems; business practices and procedures; professional ethics. Field trips to farms and professional farm management offices; estimated expense, $15.00. ¾ or 1 unit. Prerequisite: Credit or registration in Agricultural Economics 324; Agricultural Economics 325. HOLCOMB.

331. Grain Marketing. Economic and marketing problems in grain; the utilization of grain; pricing arrangements for grain, especially future markets; inventory management, operational problems at country and interior points; factors affecting grain prices; seasonal variation in grain prices. Field trips; estimated expense, $10.00. ¾ or 1 unit. Prerequisite: Agricultural Economics 230 or an elementary marketing course. HIERONYMUS.

332. **Livestock Marketing.** Same as Animal Science 332. Economic principles applied to marketing livestock and livestock products from the standpoint of producers, processors, and distributors; theoretical basis for evaluating alternative marketing systems and functions; evaluation of changes in the industry affecting marketing decisions. Field trip; estimated expense, $10.00. ¾ or 1 unit. Prerequisite: Economics 108; Agricultural Economics 230 or an elementary marketing course. BROADBENT.

334. **Marketing of Dairy Products.** Same as Dairy Science 334. Economic interrelationships of various dairy products; collective bargaining; federal milk orders, mark-up laws, marketing quotas, and other governmental regulations; lowering distribution costs; factors affecting demand and consumption; expanding markets for dairy products. Inspection trip; estimated expense, $5.00. ¾ or 1 unit. Prerequisite: Agricultural Economics 230 or an elementary marketing course, or twelve hours of dairy science or dairy technology. BARTLETT.

335. **Economics of Food Distribution.** Same as Horticulture 335. Analysis of (1) marketing structures and operations in the manufacture and wholesale and retail distribution of food; (2) effects of industry organization and governmental regulations on marketing functions and efficiency; (3) consumer demand for food. ¾ or 1 unit. Prerequisite: Economics 108; Agricultural Economics 230 or an elementary marketing course. KELLY.

337. **Economic History of American Agriculture.** Same as Economics and History 337. The development of American agriculture from early colonial times to the present. Emphasis on regional development, evolution of methods and equipment, trends in marketing and credit, and the making of federal farm policy. ½ or 1 unit. Prerequisite: A college-level course in basic economics or American history. SCHWEITZER.

341. **Agricultural Statistics.** Statistical methods applied to agricultural economics including graphic presentation, frequency distribution, inference and probability, time series analysis, index numbers, analysis of variance, regression, and correlation. ½ unit. SCOTT, WEST.

342. **Agricultural Prices.** A study of the factors affecting prices of agricultural products; long-time, cyclical, seasonal, and other price movements; sources of information relating to production and demand factors; government activities as they relate to prices of agricultural products and problems in price analysis and forecasting. ¾ or 1 unit. Prerequisite: Economics 103 or 108. SCHMIDT, VANDENBORRE.

370. **Family Economics.** Same as Home Economics 370. Economic welfare of American families in terms of cost of living, standard of living, income, and net worth. ½ or 1 unit. Prerequisite: Economics 102 or 108; a course in applied statistics. DUNSING.

Rural Sociology

COURSES FOR GRADUATES

407. **Population Studies and Demographic Analysis.** Same as Sociology 407. Nature and development of population theories; population growth and measures of fertility, reproduction, mortality, morbidity, and internal migration; indices, rates, and standardizations used in analyzing compositional characteristics. Methods in population projections; relationship of economic, sociological, and psychological factors to population changes. 1 unit. Prerequisite: Twelve hours of social science and introductory statistics, or major in sociology, or consent of instructor. FOLSE.

477. **Rural Community Organization and Development.** Same as Sociology 477. Theories relating to the community concept as applied to rural life; the analysis of

rural community organization; the process of community development as applied to rural cultures in various parts of the world. Field trip; estimated expense, $5.00. 1 unit. Prerequisite: Sociology 100 or Rural Sociology 117.

487. Special Problems in Rural Sociology. Same as Sociology 487. ½ or 1 unit. Prerequisite: One unit of graduate credit in sociology; consent of instructor. STAFF.

AGRICULTURAL EDUCATION

This program leads to the Master of Science in Agricultural Education and is open only to students who have met the requirements for teaching vocational agriculture. It has been planned as a fifth year of work for students who have completed the requirements of the four-year general agriculture curriculum with major for teachers of agricultural occupations, or its equivalent. Candidates must earn four units in agriculture, two units in education, and two units in electives. The two units in education must include Educational Psychology 311 and 312, and History and Philosophy of Education 304 and 305. The courses in agriculture and the electives must be selected with the approval of the student's adviser. The electives may be in agriculture, in education, or in exceptional cases, in other fields.

A minimum of four units must be taken in residence. A maximum of four of the required eight units may be earned in extramural courses offered by the University of Illinois; of these four units, no more than two units may be in technical agriculture and no more than two units may be in education.

In order to fulfill one of the objectives of this program, that of broad general training in technical agriculture at the graduate level, the agriculture courses and electives must be selected with the approval of the adviser. In general, agriculture courses are selected from at least three subject-matter departments with no more than three units from any department.

The minimum grade-point average for admission to graduate study in agricultural education is 3.5. See pages 19 to 23.

Advisers for candidates for this degree are Assistant Dean C. D. Smith, 104 Mumford Hall; Professor Lloyd J. Phipps, 357a Education Building; and other members of the staff of the Division of Agricultural Education, College of Education.

AGRICULTURAL ENGINEERING

(Including Agricultural Mechanization)

The Department of Agricultural Engineering offers graduate work leading to the Master of Science and Doctor of Philosophy degrees with a major in agricultural engineering. The student may specialize in field power and machinery (soil dynamics, tillage and earthmoving, operations analysis, dynamics of particles and mechanisms, accelerated drying, and vehicle stability); soil and water mechanics (hydraulics of structures, agricultural hydrology, drainage, mechanics of erosion, and water resources planning); farm structures (structural analysis and design, environmental control, air contaminates, and waste disposal); or electric power and processing (system analysis for farmstead mechanization, crop processing, and physical properties of agricultural products).

The grade-point average required for admission to graduate study is 4.0 for the last sixty hours of undergraduate work; however, applications of those with averages below 4.0 but above 3.75 are reviewed individually by the departmental graduate committee and admission may be recommended if credentials are satisfactory.

Candidates for the master's degree must have the equivalent of the undergraduate curriculum at the University of Illinois.

Candidates for the Doctor of Philosophy must fulfill all the standard requirements of the Graduate College as noted on pages 46 to 48. The program provides for a

major in agricultural engineering with a minor in other graduate departments of engineering, mathematics, physics, including soil physics, or other disciplines in the physical sciences.

Opportunity for independent study and research is an important part of both the Master of Science and the doctorate programs. Research opportunities are available in both the Agricultural and Engineering Experiment Stations. For the master's degree, a thesis involving an analytical or experimental investigation and satisfying about one-fourth of the credit for the program is normally required.

Inquires concerning graduate work should be directed to Frank B. Lanham, Head of the Department, 245 Agricultural Engineering Building.

GRADUATE FACULTY

Professors: F. B. Lanham (Head of Department), H. H. Beaty, E. L. Hansen, R. C. Hay, B. A. Jones, Jr., J. W. Matthews, E. F. Olver, J. A. Weber, R. R. Yoerger.

Associate Professors: B. J. Butler, J. O. Curtis, D. L. Day, D. R. Hunt, H. B. Puckett, G. C. Shove.

Assistant Professors: H. P. Bateman, R. F. Espenschied.

Agricultural Engineering

COURSES FOR GRADUATES

400. **Research Orientation.** Discussion of the philosophy and methods of research, thesis preparation, and publication of research findings. No credit.

436. **Dynamics of Farm Machine Elements.** Advanced study of the dynamics of farm machine elements with specific reference to functional operation, stresses, and fatigue life. 1 unit. Prerequisite: Agricultural Engineering 236 and 336, or equivalent. Yoerger.

446. **Dynamics of Tillage, Traction, and Earthmoving.** Relationship of soil parameters to forces acting on tillage tools, earthmoving components, and traction devices; stress strain relationships in soil, failure patterns, and pulverization; speed effects, energy requirements, power trains, and model simulation. 1 unit. Prerequisite: Bachelor of Science degree in engineering or consent of instructor. Weber.

490. **Seminar.** Presentation and discussion of current research and literature in agricultural engineering. ¼ unit.

496. **Problems in Agricultural Engineering.** Investigation and report on problems in farm machinery, farm power, rural electrification, soil and water control, rural housing and farm structures. 1 unit. Prerequisite: Consent of head of department. Staff.

499. **Thesis Research.** 0 to 4 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. **Instrumentation and Measurements.** Same as Mechanical Engineering 311. Accuracy, precision, and statistical consideration of measurement data; dynamics of measurement; displacement, velocity, acceleration, force, torque, pressure, and temperature measurements; mechanical impedance; measurements on fluids; instrumentation systems. ¾ or 1 unit. Prerequisite: Senior standing in engineering or science. Yoerger.

336. **Design of Agricultural Machinery.** Determining machine requirements and specifications, design layout, effective use of materials and shapes, relation of

design to problems. ½ unit. Prerequisite: Mechanical Engineering 224; Agricultural Engineering 236. HUNT.

346. **Tractors and Prime Movers.** Engineering aspects of design and application of tractors for farm, construction, and military use; thermodynamics of engines, turbines, and other power units; measurement of power and efficiencies, transmission of power, traction, stability, and hydraulic circuitry. ¾ unit. Prerequisite: Mechanical Engineering 209, Agricultural Engineering 146, or equivalent. WEBER.

356. **Soil Conservation Structures.** Hydrology, hydraulics, design, construction, and cost estimating of soil and water conservation structures; relationship of slopes, soils, crops, and practices in soil conservation and flood control. ½ unit. Prerequisite: Theoretical and Applied Mechanics 235; Agricultural Engineering 277 or equivalent. JONES.

357. **Land Drainage.** The design, construction, performance, and maintenance of surface tile and open ditch drainage systems. ½ unit. Prerequisite: Theoretical and Applied Mechanics 235. JONES.

376. **Advanced Design of Farm Structures.** Timber, steel, and concrete building design, with emphasis on structures for agricultural production. ½ unit. Prerequisite: Civil Engineering 262; Agricultural Engineering 277 or equivalent. CURTIS.

387. **Agricultural Process Engineering.** Principles, design factors, equipment, and controls of systems for drying, refrigerating, reducing, pelleting, blending, cleaning, sorting, and treating agricultural crops and products. ½ unit. Prerequisite: Agricultural Engineering 286 or Chemical Engineering 363. SHOVE.

396. **Special Problems.** An agricultural problem is selected for study, investigation, and report wherein a satisfactory solution requires a strong background in engineering education. ½ unit. Prerequisite: Senior standing in engineering. STAFF.

Agricultural Mechanization

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Special Problems.** An agricultural problem with engineering implications is selected for study, investigation, and report wherein a satisfactory solution does not require a background in engineering education. For non-engineering students only. ½ unit. Prerequisite: Minimum grade-point average of 3.5; consent of instructor and head of department. Specific approval of the associate dean in advance of registration is required for a second special problems course. STAFF.

331. **Farm Machinery Technology.** Application, functional operation, and management of tillage, planting, chemical application and harvesting machinery, incorporating current engineering, agronomic, and biological research results. For students presently in or preparing for teacher training or extension education. ¾ unit. Prerequisite: Agricultural Mechanization 112 or 221. BUTLER.

361. **Development and Function of Family Housing.** Same as Home Economics 361. Study of principles and problem solutions in family housing; basic functions, plan patterns, types, materials, and structure; economic influences, costs, and adaptations; personal and public interest. ¾ unit. HANSEN.

381. **Electro-Mechanical Agricultural Systems.** Application of electric power and mechanical equipment to livestock production, crop conditioning, and materials handling systems for efficient use of time, power, and labor. Principles of planning materials handling systems; requirements for environmental control in

agricultural production; electric controls circuits; and factors affecting drying, cooling, and processing of crops. ¾ unit. Prerequisite: Agricultural Mechanization 281 or graduate standing in agriculture. BEATY.

AGRONOMY

The Department of Agronomy offers graduate work leading to the Master of Science and Doctor of Philosophy in Agronomy. The student may specialize in (1) crops: breeding and genetics, crop evolution, crop production, biometry, forage crops, morphological development, physiology, plant chemistry, weeds and their control; or (2) soils: biology, chemistry and biochemistry, fertility, genesis, morphology and classification, management, physical and colloidal chemistry, physical edaphology, physics.

The student must show promise of achievement in his chosen field, must have a grade-point average of 3.75 or higher for the last sixty semester hours of work completed, and must be approved by the Department of Agronomy. For students having grade-point averages below 4.0 but above 3.75, only those having unusually strong training in the basic sciences are considered for admission.

Adequate preparation for graduate work in soils includes courses in physics, chemistry, geology, microbiology, and mathematics; and in crops, courses in botany, chemistry, genetics, and statistics. A pamphlet giving specific prerequisites and requirements may be obtained from the head of the Department of Agronomy.

A candidate for the Master of Science must present an acceptable thesis, unless this requirement is waived by petition, and pass an oral examination.

Agronomy courses totaling four units fulfill the requirements for a first minor for the Doctor of Philosophy.

GRADUATE FACULTY

Professors: M. D. THORNE (Head of Department), S. R. ALDRICH, D. E. ALEXANDER, A. H. BEAVERS, A. W. BURGER, J. M. DEWET, E. B. EARLEY, J. B. FEHRENBACHER, J. W. GERDEMANN, J. E. GIESEKING, H. H. HADLEY, R. H. HAGEMAN, J. B. HANSON, J. R. HARLAN, C. N. HITTLE, A. L. HOOKER, J. A. JACKOBS, R. W. JUGENHEIMER, A. KLUTE, L. T. KURTZ, J. R. LAUGHNAN, E. R. LENG, S. W. MELSTED, R. T. ODELL, J. W. PENDLETON, D. B. PETERS, M. B. RUSSELL, W. O. SCOTT, F. W. SLIFE, F. J. STEVENSON, E. H. TYNER.

Associate Professors: R. L. BERNARD, C. M. BROWN (Associate Head of Department), S. G. CARMER, R. L. COOPER, J. W. DUDLEY, R. L. JONES, E. L. KNAKE, D. A. MILLER, R. J. MILLER, B. R. SABEY, R. D. SEIF, R. O. WEIBEL, L. F. WELCH, C. M. WILSON, J. T. WOOLLEY.

Assistant Professors: T. D. HINESLY, R. J. LAMBERT, E. B. PATTERSON, R. W. RINNE, E. C. A. RUNGE, W. M. WALKER, EVELYN J. WEBER.

COURSES FOR GRADUATES

400. Seminar. Discussions of current literature in crops and soils. Required of all graduate majors in agronomy. No credit. STAFF.

402. Chemical Properties of Soil: Their Relations to Soil Development and Plant Growth. Chemical properties of soils and soil materials; their significance in soil development and in growth and nutrition of crop plants. Lectures, discussions, assigned reading, and bibliography. 1 unit. Prerequisite: Agronomy 101; Chemistry 101, 102, or 122, or equivalent. MELSTED.

403. Genesis, Morphology, and Classification of Soils. Historical review of work in soil genesis; genetic factors of soil formation; soil-forming processes and reactions;

classification and nomenclature of soils; properties and distribution of the major soil groups of the world. Assigned reading. ¾ unit. Offered in 1968-1969 and in alternate years. Prerequisite: Agronomy 301 or consent of instructor. FEHREN-BACHER.

405. **Colloidal Chemistry of Soils.** Soil components, their nature, and their influence on the physical, chemical, biological, and electrokinetic properties of soils. Lectures, discussions, and assigned reading. 1 unit. Prerequisite: Chemistry 340 and 341, or equivalent. GIESEKING.

411. **Soil Physics.** The derivation and application of the fundamental physical principles and laws which govern the behavior of soils. Transport phenomena and physical characteristics of soils are emphasized. Lectures, discussions, and assigned reading. 1 unit. Prerequisite: Chemistry 340 and 341 or equivalent. KLUTE.

412. **Soil Organic Matter.** Basic considerations in organic matter transformation; geochemistry of organic matter; nature and origin of humic substances; reactions of organic matter in soils and sediments. Lectures, discussions, and assigned reading. Offered in 1969-1970 and in alternate years. 1 unit. Prerequisite: Agronomy 309 or consent of instructor. STEVENSON.

414. **Physical Chemistry of Clays and Soils.** Same as Mining Engineering and Ceramic Engineering 414. The application of physical chemical principles and concepts to surfaces and adsorption on surfaces. Silicate surfaces and water adsorption are emphasized. 1 unit. Prerequisite: Chemistry 340 and 341, or equivalent, or consent of instructor. R. J. MILLER.

422. **Pasture, Range, and Soil Conservation Research.** Discussion and study of data and literature pertaining to pastures, range, and soil conservation; application of research methods to the evaluation of forage species in the management and utilization of pasture and range and to soil conservation. 1 unit. Prerequisite: Agronomy 121, 321, or 322. HITTLE.

423. **Cytogenetic and Evolutionary Basis of Plant Breeding.** Nature and origin of crop species; genetic and cytogenetic basis for developing special plant materials and the use of such materials in breeding programs. Emphasis on discontinuous variation. 1 unit. Prerequisite: Agronomy or Horticulture 323, or equivalent, or consent of instructor. HADLEY.

424. **Mineral Nutrition of Plants.** Same as Botany and Horticulture 424. A study of the uptake, transport, and metabolic utilization of mineral nutrients by plants. The scope of the course is to present the essentiality of various anions and cations in the light of metabolic activity and constituency in functional plant compounds. Major emphasis is placed on metabolic activity and function of the elements. 1 unit. Prerequisite: Botany 330 or consent of instructor. HAGEMAN.

429. **The Evolution of Agricultural Economies.** Same as Anthropology and Geography 429. The problems concerning the development of the several basic food crop economies are studied from the point of view of geographical environment, the available archaeological and ethnographic evidence, and from the point of view of agronomy and plant genetics. The regional emphasis varies from year to year. 1 unit. Prerequisite: Consent of instructor. C. S. ALEXANDER, STAFF.

436. **Advanced Plant Physiology: Photosynthesis.** Same as Botany 436. A lecture and laboratory course dealing with physiological, biochemical, and biophysical aspects of photosynthesis. 1 unit. Prerequisite: One year each of college biology, chemistry, and physics, or consent of instructor. GOVINDJEE, OGREN.

440. **Design and Analysis of Biological Experiments, I.** Same as Animal Science, Dairy Science, Forestry, Horticulture, and Veterinary Medical Science 440. A study of statistical methods as tools for research. Principles of designing experiments and the methods of analysis for various kinds of designs are considered from

the viewpoint of when and how to use the available simpler designs and analytical methods. 1 unit. Prerequisite: Consent of instructor. SEIF, WALKER.

441. **Design and Analysis of Biological Experiments, II.** Same as Animal Science, Dairy Science, Forestry, Horticulture, and Veterinary Medical Science 441. A continuation of Agronomy 440 moving into the more complex designs and methods of analysis. 1 unit. Prerequisite: Agronomy 440 or equivalent. CARMER, WALKER.

442. **Quantitative Aspects of Plant Breeding.** A study of the theoretical bases for plant breeding procedures with special emphasis on the relationship between type and source of genetic variability, mode of reproduction, and effectiveness of different selection procedures. 1 unit. Prerequisite: Agronomy 323 or equivalent; Agronomy 441 or equivalent. DUDLEY.

493. **Advanced Studies in Agronomy.** Directed and supervised detailed study of selected problems or topics. ¼ to 2 units. Prerequisite: Consent of instructor. Study may be in any one of the following fields:
(a) **Soil Chemistry.**
(b) **Soil Fertility.**
(c) **Soil Physics.**
(d) **Soil Classification and Pedology.**
(e) **Soil Mineralogy.**
(f) **Soil Microbiology.**
(g) **Plant Breeding and Genetics.**
(h) **Plant Physiology.**
(i) **Weed Control.**
(j) **Crop Morphology.**
(k) **Crop Production and Ecology.**
(l) **Statistical Techniques and Data Processing.**

499. **Thesis Research.** 0 to 4 units.
(a) **Soils.** ALDRICH, BEAVERS, FEHRENBACHER, GIESEKING, HINESLY, JONES, KLUTE, KURTZ, MELSTED, MILLER, ODELL, PETERS, RUNGE, SABEY, STEVENSON, TYNER, WALKER, WELCH.

(b) **Crops.** ALEXANDER, BERNARD, BROWN, BURGER, CARMER, COOPER, DEWET, DUDLEY, EARLEY, GERDEMANN, HADLEY, HAGEMAN, HANSON, HARLAN, HITTLE, HOOKER, JACKOBS, KNAKE, LAMBERT, LAUGHNAN, LENG, MILLER, PATTERSON, PENDLETON, RINNE, SCOTT, SEIF, SLIFE, WEBER, WEIBEL, WILSON, WOOLLEY.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Advanced Special Problems.** Individual problems in crops or soils. Graduate students majoring in agronomy do not receive graduate credit for this course. ½ to 2 units. Prerequisite: Consent of instructor. STAFF.

301. **Soil Survey with Emphasis on Illinois Soils.** Properties and methods used in distinguishing soils; characteristics and distribution of different soils in Illinois and the cause of these soil differences; the influences of differences in Illinois soils upon their proper use and management. Laboratory work includes instruction in the use of soil maps, training in mapping soils, and field trips to examine representative soils. Field trips; estimated cost, $10.00. Credit is not given toward the Ph.D. for major or sole minor in Agronomy–Soils. ½ unit. Prerequisite: Agronomy 101. ODELL.

303. **Soil Fertility.** Influence of chemical and microbiological properties of soils on crop production; rhizobial fixation and other fertility effects of crop sequence; fertilizer needs, sources, materials, and applications. Students taking this course do not receive credit for Agronomy 309 and 310. Credit is not given toward the

Ph.D. for major or sole minor in Agronomy–Soils. ½ unit. Prerequisite: Agronomy 101. Staff.

304. **Soil Management and Conservation.** Influence of physical properties of soils on crop production; roles of drainage, tillage, crop sequence, and soil characteristics in land management. Students taking this course do not receive credit for Agronomy 309 and 310. Credit is not given toward the Ph.D. for major or sole minor in Agronomy–Soils. ½ unit. Prerequisite: Agronomy 101. Millington.

309. **Intermediate Soil Science, I.** Genesis, organic matter, microbiology, and mineralogy of soils. This course, if followed by Agronomy 310, is intended to provide a science-based treatment of the field of soil science. Credit is not given for Agronomy 309 in addition to Agronomy 303 and 304. 1 unit. Prerequisite: Agronomy 101; Botany 100; Chemistry 122 and 133; Microbiology 100 and 101; two 200- or 300-level courses in plant science; credit or registration in Physics 101. Melsted, Staff.

310. **Intermediate Soil Science, II.** Soil fertility, soil physics, and soil-plant-atmosphere relationships. This course with Agronomy 309 is intended to provide a science-based treatment of the field of soil science. Credit is not given for Agronomy 310 in addition to Agronomy 303 and 304. 1 unit. Prerequisite: Agronomy 101; Botany 100; Chemistry 122 and 133; two 200- or 300-level courses in plant science; credit or registration in Physics 102 and Mathematics 132 or 133. Melsted, Staff.

312. **Farm Appraisals.** Same as Agricultural Economics 312. Valuation methods and value bases of farm real estate. Includes legal aspects of appraisal work, appraisal theory and procedures, condemnation appraisal, characteristics of the farmland market, engineering and agronomic data for farm appraisals, and practice appraisals. Seven field trips; cost about $7.00. 1 unit. Prerequisite: Agronomy 101 and Agricultural Economics 220, or equivalent. Reiss.

313. **Soil Mineral Analysis.** Specialized analytical procedures for determinations of soil minerals and their properties; mineralogy of soils and relationships to soil genesis and fertility. 1 unit. Prerequisite: Agronomy 101 or consent of instructor. Beaver, Jones.

321. **Ecological and Physiological Factors Affecting Crop Production.** The environmental requirements of crop plants and their physiological bases; the adequacy of the environment provided by crop land in the United States as a function of management, soils, and climate; and distribution and yield of selected crops as a function of environment. ¾ unit. Prerequisite: Botany 100; Chemistry 102 (new), 132 or 133. Hanson.

322. **Forage Crops and Pastures.** Roughage production, forage crop characteristics and ecology, grasslands of farm and range as related to animal production and soil conservation. Lectures and discussions. ½ unit. Prerequisite: Agronomy 121. D. A. Miller.

323. **Principles of Plant Breeding.** Same as Horticulture 323. Genetic and cytological variation in crop plants, the production and control of such variation in developing varieties and hybrids, and the maintenance of high quality seed stocks. Field trips; estimated cost, $5.00. 1 unit. Prerequisite: Agronomy 110 or equivalent; Botany 100. Hittle.

326. **Weeds and Their Control.** Weeds, their introduction, methods of dissemination, reproduction, and control; a characterization of the common weeds of the Midwest. ½ unit. Prerequisite: Agronomy 121. McGlamery.

365. **Digital Computer Methods for Statistical Data Processing.** Same as Computer Science 365. A study of methods for efficient utilization of high-speed equipment in processing of statistical data. Emphasis is on principles of application of

computing equipment to the solution of statistical problems. Numerous examples are given and actual problem solution by the student is accomplished. 1 unit. Prerequisite: Computer Science 101 and a course in statistics or statistical methods, or consent of instructor. CARMER.

377. **Diseases of Field Crops.** Same as Plant Pathology 377. A study of the symptoms of the major field crop diseases, life histories of causal organisms, and methods of control. Offered in 1969-1970 and in alternate years. ¾ unit. Prerequisite: Plant Pathology 204 or equivalent. HOOKER.

ANIMAL SCIENCE

The Department of Animal Science offers graduate work leading to the Master of Science and Doctor of Philosophy in Animal Science. Research may be pursued in the following areas of specialization: (1) population and immunogenetics, (2) physiology of reproduction including endocrinology, (3) animal nutrition, (4) nutritional biochemistry, (5) ecology, and (6) meats technology. In addition, a student who expects to terminate the graduate program at the master's level may pursue work in animal production. Beef cattle, poultry, sheep, swine, and a wide variety of laboratory animals are available for use in conducting research in the above areas.

The minimum grade-point average for admission to graduate study in animal science is 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

Courses in biological and physical sciences and mathematics are essential preparation for graduate work in any specialized area of animal science. Candidates specializing in the areas of animal nutrition or nutritional biochemistry must have training equivalent to one five-hour course each in quantitative analysis and organic chemistry; a course in physical chemistry also is strongly recommended. Candidates specializing in meats technology should have undergraduate training in meat evaluation, use, and/or processing, and in microbiology. Students lacking adequate background to register in graduate courses at the University of Illinois are expected to remove course deficiencies during the first year of graduate study.

GRADUATE FACULTY

Professors: D. E. BECKER (Head of Department), H. H. DRAPER, P. J. DZIUK, R. M. FORBES, U. S. GARRIGUS, E. E. HATFIELD, A. H. JENSEN, J. KASTELIC, S. P. MISTRY, A. V. NALBANDOV, H. W. NORTON, B. A. RASMUSEN, H. M. SCOTT.

Associate Professors: D. J. BRAY, G. A. LEVEILLE.

Assistant Professors: W. W. ALBERT, D. H. BAKER, B. G. HARMON, F. C. HINDS, J. R. ROMANS.

COURSES FOR GRADUATES

400. **Presentation of Experimental Results.** Preparation of technical material for oral or written presentation. ¼ unit. DZIUK.

401. **Topics in Ruminant Meat Animal Research.** A critical review and evaluation of certain aspects of ruminant nutrition and physiology with emphasis on techniques and procedures currently employed in research and the resultant application of research results to current as well as future meat animal production. Prerequisite: Consent of instructor. 1 unit. GARRIGUS, HINDS.

402. **Principles of Sheep and Wool Production.** Basic considerations in sheep and wool production and lamb feeding. Reports of research. ½ unit. Prerequisite: Consent of instructor. GARRIGUS.

403. Techniques and Topics in Animal Research. Discussion and study of literature pertaining to animal research; application of experimental technics; special topics; review of research in current problem areas. ½ unit. Prerequisite: Consent of instructor.

404. Poultry Nutrition. A review of the current literature in nutrition and its applicability to the avian species. ½ unit. Prerequisite: Consent of instructor. SCOTT.

405. Advanced Animal Genetics. Genetic theory, analysis of animal breeding problems, genetic results of selection, and different systems of breeding. 1 unit. Prerequisite: Animal Science 305 or equivalent. NORTON.

406. Physiology of Reproduction. Same as Zoology 406. Comparative physiology of reproduction and endocrinology of domestic and laboratory animals; fertility and sterility. Lectures and laboratory. 1 unit. NALBANDOV.

407. Laboratory Methods in Animal Genetics. ½ to 1 unit. Combined credit in Animal Science 407 and 408 may not exceed two units. Prerequisite: Consent of instructor. NORTON.

408. Laboratory Methods in Physiology of Reproduction. Same as Zoology 408. ½ to 1 unit. Combined credit in Animal Science 407 and 408 may not exceed two units. Prerequisite: Consent of instructor. NALBANDOV.

410. Research Methods in Animal Science. Intended to give students training and experience in various techniques used in research with poultry, sheep, swine, beef cattle, and meats. ¼ to 1 unit; may be repeated for credit not to exceed a total of one unit. Prerequisite: Consent of instructor. GARRIGUS, JENSEN, SCOTT, STAFF.

411. Population Genetics and Animal Breeding. Same as Dairy Science 411. The mathematical theory of population genetics and its application to the improvement of farm animals; results of different systems of mating and the expected gains from different methods of selection. 1 unit. Prerequisite: Animal Science 110 or equivalent. A knowledge of elementary algebra is essential. TOUCHBERRY.

412. Advanced Endocrinology. Same as Dairy Science, Physiology, and Zoology 412. Seminar, lectures, student reports, and discussions of recent advances in endocrinology. ½ unit; may be repeated for credit not to exceed a total of two units. Prerequisite: Consent of instructor. GORSKI, NALBANDOV.

420. Comparative Nutrition. Physiological aspects of the nutrition of higher animals and man, including the digestion, utilization, and function of nutrients, and the effects of dietary deficiencies. 1 unit. Prerequisite: Chemistry 350 and 355. FORBES, MISTRY.

421. Topics in Nutritional Biochemistry. Biochemical aspects of the nutrition of higher animals and man, with emphasis on the function and metabolism of nutrients. 1 unit. Prerequisite: Animal Science 420. DRAPER, MISTRY.

440. Design and Analysis of Biological Experiments, I. Same as Agronomy, Dairy Science, Horticulture, and Veterinary Medical Science 440. A study of statistical methods as tools for research. Principles of designing experiments and the methods of analysis for various kinds of designs are considered from the viewpoint of when and how to use the available simpler designs and analytical methods. 1 unit. Prerequisite: Consent of instructor. CARMER.

441. Design and Analysis of Biological Experiments, II. Same as Agronomy, Dairy Science, Horticulture, and Veterinary Medical Science 441. A continuation of Animal Science 440 moving into the more complex designs and methods of analysis. 1 unit. Prerequisite: Animal Science 440 or equivalent. CARMER.

463. Radioisotopes in Biological Research: Principles and Practice. See Veterinary

Medical Science 463. ¾ unit. Prerequisite: Quantitative chemistry; one year each of mathematics, physics, biology, and/or consent of instructor. TWARDOCK.

481. Animal Biochemical Laboratory Techniques. Same as Dairy Science 481. Theory and application of biochemical laboratory techniques to research in the animal-oriented biological sciences. Isolation, characterization, and analysis of biological compounds including enzymes, metabolic intermediates, and cellular components; determination of metabolic pathways and processes. 1 unit. Prerequisite: Chemistry 350 and 355. LARSON.

496. The Use of Carbon-14 in Labeling Techniques. Same as Chemistry 496. A comprehensive study of the chemistry of carbon-14. The laboratory work deals with vacuum-line manipulations and synthesis, degradation, and assay of radioactive carbon compounds. ¾ or 1 unit. Prerequisite: Chemistry 336, 337, and 338, or equivalent; consent of instructor. CONRAD, NYSTROM.

499. Thesis Research. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Beef Production. The principles of feeding and management of beef cattle; financial aspects of beef production; diseases, parasites, and breeding difficulties of beef cattle. Lectures, demonstrations, and discussions. ¾ unit. Prerequisite: Animal Science 220 or 221 or equivalent. ALBERT.

302. Sheep Production. The sheep and wool industries; principles and practices of various phases of production. ¾ unit. Prerequisite: Animal Science 220 or 221 or equivalent. GARRIGUS.

303. Pork Production. The place of the swine enterprise on the farm; selecting, breeding, feeding, managing, and marketing of swine for greatest profit. ¾ unit. Prerequisite: Animal Science 220 or 221 or equivalent. HARMON, JENSEN.

304. Poultry Management. Application of scientific principles to the management of poultry. Undergraduate students may register for four hours credit with laboratory or for three hours credit without laboratory. ¾ unit. Prerequisite: Animal Science 220 or 221 or equivalent. BRAY, SCOTT.

305. Genetics and Animal Improvement. Same as Dairy Science 305. The principles of heredity and their application to the problems of animal improvement. ¾ unit; S, ½ unit. Prerequisite: Animal Science 110 or equivalent. RASMUSEN, TOUCHBERRY.

320. Nutrition and Digestive Physiology of Ruminants. Same as Dairy Science 320. The physiology and microbiology of digestion in the ruminant and biochemical pathways of utilization of the absorbed nutrients for productive purposes. ¾ unit. Prerequisite: Animal Science or Dairy Science 221. DAVIS, HINDS.

325. Principles of Animal Nutrition. Principles of animal nutrition and their application to veterinary practice. This course is designed primarily for students in veterinary medicine. 1¼ units; credit is not allowed for Animal Science 221 and 325. Prerequisite: Chemistry 354 or 350 and 355. LEVEILLE, HATFIELD.

330. Reproduction and Artificial Insemination of Farm Animals. Same as Dairy Science 330. The anatomy and physiology of reproduction in farm animals, the principles of artificial insemination, and the factors affecting conception in natural and artificial breeding. ¾ unit; S, ½ unit. Prerequisite: Zoology 104 and either Dairy Science 100 or Animal Science 100. GRAVES.

332. Livestock Marketing. Same as Agricultural Economics 332. Economic principles applied to marketing livestock and livestock products from the standpoint of producers, processors, and distributors; theoretical basis for evaluating alternative

marketing systems and functions; evaluation of changes in the industry affecting marketing decisions. Field trip; estimated cost, $10.00. ¾ or 1 unit. Prerequisite: Economics 103; Agricultural Economics 230 or an elementary marketing course. BROADBENT.

ANTHROPOLOGY

The Department of Anthropology offers graduate work leading to the Master of Arts and Doctor of Philosophy. Courses and guided study provide a broad coverage of anthropology with concentrations in ethnology of Latin America, aboriginal North America, Northern Eurasia, Japan, Indonesia, Southeast and South Asia, and Africa south of the Sahara; culture historical and archaeological methods; culture change and modernization in complex societies; urban anthropology; human ecology; structural and formal analysis of cultural systems; ethnolinguistics; and ethnomusicology. Relevant courses are offered in other fields, e.g., linguistics, history, sociology, geography, agricultural economics, life sciences, and preventive medicine. The department also supports student attendance at field schools and study in mathematics, languages, and other areas at summer institutes.

Original research in the field, laboratory, and library is financially supported by the department. Opportunities include participation in faculty research projects, attendance at University of Illinois archaeological and ethnological field schools held every summer, and independent graduate student research in the United States and abroad. For work on campus, the library and computer resources at the University of Illinois are outstanding.

Applicants for admission as first-year graduate students are required to have a grade-point average of 4.0 for the last sixty hours of undergraduate training. Exceptions may be made by a special committee for those applicants with a grade-point average between 3.5 and 4.0, particularly if the student displays substantial evidence of having acquired special skills or of having had significant experience relevant to anthropology. A student who does not have an undergraduate major in anthropology or its equivalent may be permitted to register for graduate courses, but will be required to make up any deficiencies.

A detailed statement of requirements for higher degrees and additional information about departmental programs and policies is available on request.

A candidate must demonstrate ability to read two languages. He may choose two from Group A, or one from Group A and one from Group B. *Group A:* German or Dutch, Russian, Japanese, Chinese; *Group B:* French, Italian, Spanish, Portuguese. In all cases, the candidate must obtain the approval of his adviser and the department, the criteria of approval being that the languages must be research tools and they must contribute to the candidate's graduate program. The department will consider individual applications to take the one language high-level proficiency examination (see page 47.)

With the approval of the adviser and the department, a candidate may satisfy the minor requirement by taking courses within the department. Approval is given only in those cases in which a subfield, such as biological anthropology or anthropological linguistics, constitutes an essential part of the candidate's overall program.

GRADUATE FACULTY

Professors: E. M. BRUNER (Head of Department), J. B. CASAGRANDE, D. W. LATHRAP, F. K. LEHMAN, O. LEWIS, J. C. MC.GREGOR, B. NETTL, D. B. SHIMKIN, J. H. STEWARD.

Associate Professors: H. A. GOULD, A. H. JACOBS, D. W. PLATH, R. T. ZUIDEMA.

Assistant Professors: J. BRUKMAN, A. H. ROHN, JR., L. ROSEN, H. M. ROSS, J. F. YEGERLEHNER.

Instructor: C. J. BAREIS.

COURSES FOR GRADUATES

401. General Anthropology, I. A comprehensive survey of the various subfields of anthropology, with special reference to contemporary trends in theory and method: anthropology among the sciences, historical perspectives, human evolution and variation, the nature of culture, cultural evolution, the ecological approach, archaeology, linguistics. 1 unit. Prerequisite: Twelve hours of anthropology or consent of instructor.

402. General Anthropology, II. Continuation of Anthropology 401. Cultural typology, technology and economic organization, social structure, political organization, religion, art, personality and culture, processes of culture change, acculturation, applied anthropology, the logic of anthropological research, field methods. 1 unit. Prerequisite: Anthropology 401 or consent of instructor.

409. Field Methods in Linguistics. Same as Linguistics 309. The recording and analysis of a spoken language with a native speaker of that language as an informant. ½ or 1 unit. Prerequisite: Linguistics 300 or 301, or consent of instructor. LEHMAN, YEGERLEHNER.

410. Advanced Field Methods in Linguistics. Same as Linguistics 310. Advanced analysis of a spoken language with a native speaker of that language as an informant. ½ or 1 unit. Prerequisite: Anthropology 309 or equivalent. LEHMAN, YEGERLEHNER.

429. The Evolution of Agricultural Economies. Same as Agronomy and Geography 429. The problems concerning the development of the several basic food crop economies are studied from the point of view of geographical environment, the available archaeological and ethnographic evidence, and from the point of view of agronomy and plant genetics. The regional emphasis varies from year to year. 1 unit. Prerequisite: Consent of instructor. LATHRAP, STAFF.

440. Problems in Physical Anthropology. A seminar designed to involve students in the theoretical and methodological approaches to problem areas in physical anthropology. 1 unit. May be repeated for additional credit. Prerequisite: Anthropology 340; consent of instructor.

450. Seminar in Anthropology. Analysis of selected topics of special interest in anthropology. 1 unit. Students may reregister in this course up to a total of two units. STAFF.

451. Social Structure. This course is intended to acquaint the student with the descriptive techniques and methods of structural and functional analysis currently employed by social anthropologists in the study of primitive social groups and their methods of operation. 1 unit. Prerequisite: Consent of instructor. STAFF.

452. Research Problems in Archaeology. Seminar oriented to current research problems in archaeology, designed to acquaint students with theoretical and methodological aspects of particular problems, and to develop a critical perspective of archaeological research. Course may be repeated for additional credit. 1 unit. Prerequisite: Consent of instructor. MCGREGOR.

453. The Formal Analysis of Kinship Systems. A survey of a variety of the world's systems of kinship, marriage, and family organization. Concentration on the distinctive properties of kinship systems as a species of social structure, on the formal apparatus for describing and understanding them and their functions, and on the theory of kinship that arises from the use of such formal apparatus. ½ or 1 unit. Prerequisite: Consent of instructor. LEHMAN.

460. Theories and Methods in Anthropology. A seminar course identifying, investigating, and evaluating the various theories and trends, as well as methods employed by anthropologists. 1 unit. CASAGRANDE.

461. **The Cultural Approach in Anthropology.** Seminar on the historical, comparative, and holistic methods of anthropology. 1 unit. Prerequisite: Consent of instructor. STEWARD.

462. **Cultural Method and Contemporary Native Populations.** Seminar on the use of anthropological methods in the analysis of native populations, with special reference to studies of communities, classes, castes, and other subcultural groups. 1 unit. Prerequisite: Anthropology 461 or consent of instructor. STEWARD.

463. **Seminar on Field Methods and Research Designs in Cultural Anthropology.** Critical examination of field methods and research designs as reflected in selected studies covering the past seventy years, ranging from early missionary reports to those of contemporary field workers. An effort is made to discern major trends in methodology. Community studies and comparative studies on both the tribal and peasant levels are examined. 1 unit. Prerequisite: Consent of instructor. STAFF.

471. **Personality, Culture, and Society.** A seminar on selected topics in culture and personality. The emphasis varies from year to year: possible topics include the interrelationship between social systems and personality, national character studies, comparative education, cultural learning and transmission, the psychological concomitants of cultural change. 1 unit. Prerequisite: Consent of instructor. STAFF.

489. **Readings in Anthropology.** Individual guidance in intensive readings in the literature of one or more subdivisions of the field of anthropology, selected in consultation with the adviser in accordance with the needs and interest of the student. ½ or 1 unit. Prerequisite: One semester of graduate work in anthropology; consent of adviser. STAFF.

490. **Individual Topics in Anthropology.** Supervised individual investigation or study of a topic not covered by regular courses. The topic selected by the student and the proposed plan of study are approved by the adviser and the staff member who supervises the work. 1 to 4 units. Prerequisite: Consent of instructor. STAFF.

499. **Thesis Research.** Preparation of theses. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Introduction to Linguistics.** Same as Linguistics 300. An introduction to the science of descriptive linguistics. ½ unit. Prerequisite: Fulfillment of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. STAFF.

307. **Introduction to Mathematical Linguistics.** Same as Linguistics 307. Principles of set theory, logic and formal systems, group theory, and automata theory; introduction to the formal theory of grammars. 1 unit. Prerequisite: Linguistics 300.

315. **Area Studies in Ethnomusicology.** Same as Music 317. A seminar devoted to intensive study in the music of one specific culture, e.g., Japan, China, Indonesia, India, the Near East, African and New World Negro, European and American folk cultures, American Indian. ½ unit. Prerequisite: Senior standing in music or consent of instructor. NETTL.

316. **Introduction to Music of the World's Cultures.** Same as Music 316. An introduction to non-Western and folk music, to the role of music in the world's societies, and to the methods of collecting and studying music in non-literate, folk, and Asian high cultures. For students outside the School of Music. ½ unit. Prerequisite: Anthropology 103 or consent of instructor. NETTL.

317. **Languages of the World.** Same as Linguistics 317. A survey of the main language families of the world from both genetic and typological points of view, with special

reference to the theory of syntactic descriptions. ½ or 1 unit. Prerequisite: Linguistics 300 or consent of instructor. YEGERLEHNER.

320. **Political Anthropology.** The comparative and analytic study of the political systems of representative non-Western peoples. Attention is also paid to the transformations of native political institutions as consequences of colonialism and political modernization. ½ or 1 unit. Prerequisite: Anthropology 103. JACOBS.

330. **Processes of Culture Change.** The impact of modern cultures on native peoples, comparative study of the mechanisms underlying the transition to modernity in the new nations, and the psychological and structural aspects of acculturation and urbanization. ½ or 1 unit. Prerequisite: Anthropology 103 or consent of instructor. BRUNER.

331. **Aboriginal North America.** The course deals with three major topics: (1) the nature and structure of aboriginal North America as a cultural province and its ecological base; (2) distinctive and common features of American Indian cultures; (3) responses to the stresses of white contact. Selected type cultures and their adaptations to varying ecological situations are examined in detail. A student may not receive credit for both Anthropology 270 and 331. ½ or 1 unit. Prerequisite: Anthropology 260. SHIMKIN.

332. **Native Cultures of South America.** A survey of the nature and variability of the aboriginal Indian cultures of South America. Special emphasis is placed on the relationship between various typical cultures and their ecological setting. Sample cultures illustrating the full range of community stability, population density, and social complexity are studied. ½ or 1 unit. Prerequisite: Anthropology 260 or consent of instructor. ZUIDEMA.

340. **Human Evolution, I.** The principles of evolution, and a survey of the evolution of man and his progenitors to the Paleolithic. ½ or 1 unit. Prerequisite: Anthropology 240 or consent of instructor.

341. **Human Evolution, II.** The principles of human genetics, anthropological aspects of race and race formation, and hereditary and environmental factors in the biological variation of modern man. ½ or 1 unit. Prerequisite: Anthropology 240 or consent of instructor.

343. **Introduction to Primate Morphology and Behavior.** A survey of primate social behavior and the classification, morphology, and distribution of living and extinct species. Emphasis is placed on interrelationships with aspects of anthropological study. ½ or 1 unit. Prerequisite: Anthropology 340, or Zoology 101 or 104, or consent of instructor.

349. **South American Culture History, I.** An examination of the factors influencing the initial peopling of South America, the spread and diversification of hunting and gathering economies, and the development and spread of the Tropical Forest cultural pattern. 1 unit. Prerequisite: Anthropology 220 or consent of instructor. LATHRAP.

350. **South American Culture History, II.** An examination of the factors leading to the rise of civilization in the Central Andes, including the evolution of agricultural systems, the elaboration of technology, and emergence of extensive and complex political units. 1 unit. Prerequisite: Anthropology 220 or consent of instructor. LATHRAP.

351. **Archaeological Surveying: Techniques and Applications.** Familiarization with methods used in the location and recording of archaeological sites, including techniques of mapping especially adapted to the needs of archaeology. Attention is also given to means of presenting results and interpreting data derived from this work. The course involves work both in the field and in the laboratory. 1 unit. Prerequisite: Anthropology 220 or equivalent, or consent of instructor. STAFF.

352. **Precolumbian Civilizations of Mesoamerica.** The major civilizations of Mexico and Guatemala are studied. Emphasis is placed on the growth and ramification of the several major cultural traditions and on the kinds of evidence which are available as a basis for the study of the growth of political units and their interaction. ½ or 1 unit. Prerequisite: Anthropology 220 or equivalent, or consent of instructor. LATHRAP.

353. **Southwestern Archaeology.** A detailed study of one archaeological unit in the United States, covering the three broad cultures with regional variations considered chronologically and stressing interrelationships of the various cultures. ½ or 1 unit. Prerequisite: Anthropology 220 or equivalent, or consent of instructor. MC.GREGOR, ROHN.

354. **Field Techniques in Archaeology.** Participation in archaeological excavation; techniques, methods, and procedures discussed and practiced in actual working conditions. S; 1 unit. Credit may be received twice if the areas or problems concerned are different. Prerequisite: Anthropology 102 and 103, or consent of instructor. STAFF.

355. **Laboratory Techniques and Problems in Archaeology.** Laboratory work in the field; studying, evaluating, and writing final reports on preceding field work. S; 1 unit. Credit may be received twice if the areas or problems concerned are different. Prerequisite: Anthropology 102 and 103, or consent of instructor. STAFF.

356. **Physical Anthropology.** The aims and methods of physical anthropology, both osteology and somatology, with emphasis on the human skeleton. 1 unit. Prerequisite: Anthropology 102 and 103, or, with consent of instructor, a course in anatomy or comparative anatomy, physiology, or introductory zoology. MC.GREGOR.

357. **Midwestern Prehistory.** A detailed study of the midwestern archaeological area covering the broad cultures with regional variations considered chronologically and stressing their interrelationships. ½ or 1 unit. Prerequisite: Anthropology 220 or equivalent, or consent of instructor. MC.GREGOR.

358. **Prehistory of the Old World.** An examination of Old World prehistory showing developments and relationships between various cultural traditions and histories from the earliest times. ½ or 1 unit. Prerequisite: Anthropology 220 or consent of instructor. KELLER.

359. **The Mesolithic and the Origins of Food Production in the Old World.** A continuation of Anthropology 358; designed to give students an introduction to the postglacial hunting communities of Europe from around 8,000 B.C., to the origins of food production, and to the domestication of animals in Europe, the Near East, and the Mediterranean basin. 1 unit. Prerequisite: Anthropology 220; consent of instructor.

360. **Peoples of Oceania.** A survey of the groups inhabiting the islands of the Pacific, including Australia. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor. ROSS.

361. **Peoples and Cultures of Mexico and Guatemala.** A survey of the people and cultures of Middle America with special emphasis upon Mexico and Guatemala. This course begins by placing Middle America geographically, historically, and culturally within the broader Latin-American scene. The countries are first viewed as a whole and then selected ethnographic studies of specific communities are considered for comparative purposes. The Caribbean is not studied. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor. BUTTERWORTH.

362. **Patterns of Folk and Peasant Cultures.** An analysis of the development of folk and peasant cultures in various parts of the world. Data are drawn from archae-

ological and historical records as well as from contemporary ethnological studies. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor.

363. **Religion in Primitive Society.** An introduction to the study of magic and religion in nonliterate societies. The course considers theories of the origin and function of magic and religion and an analysis of magic and religion in representative primitive societies. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor.

364. **Field Work in Cultural Anthropology.** Supervised participation in field research. Technique and procedures are discussed and practiced under actual working conditions. S; 1 unit. Credit may be received twice if the areas or problems involved are different. Prerequisite: Anthropology 102 and 103; speaking knowledge of the language of the area concerned; registration in Anthropology 365; consent of instructor. Staff.

365. **Analysis of Field Data in Cultural Anthropology.** Evaluation, organization, and write-up of field data. S; 1 unit. Credit may be received twice if the areas or problems involved are different. Prerequisite: Anthropology 102 and 103; speaking knowledge of the language of the area concerned; consent of instructor. Staff.

366. **Peoples of Southeast Asia and Indonesia.** The culture, history, economy, social system, political organization, and character structure of the peoples of Indonesia, Malaya, and the Philippines. Attention also is paid to contemporary economic and political problems of the newly independent nations seen from an anthropological perspective. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor. Lehman.

367. **Peoples and Cultures of Africa.** A survey of the cultures of Africa with particular emphasis on the ecological and historical development of culture types and the behavior associated with them. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor. Jacobs.

368. **Peoples and Cultures of India.** A description and analysis of the social, economic, and religious life of the tribal and peasant peoples of contemporary India, considered against the background of Indian geography, population, language distribution, the caste system, and highlights of Indian cultural development. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor. Gould.

369. **Introduction to Human Ecology.** Same as Geography, Health Education, Physiology, Sociology, Veterinary Medical Science, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations, and physiological, psychological, and sociological adjustments to environment, regulation of population, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology; one year of anthropology, geography, geology, or sociology. Shimkin, Staff.

370. **Language, Culture, and Society.** Same as Communications and Linguistics 370. An examination of the social and cultural functions of language, with particular emphasis on the application of linguistic methods and findings to selected problems in the social sciences. ½ or 1 unit. Brukman.

371. **Culture and Personality.** A cross-cultural comparative analysis and evaluation of current theories of culture and personality formation. The course is concerned with the socio-cultural matrix in which personality develops, as well as with the application of personality concepts, especially those derived from psychoanalytic theory, to the study of primitive and modern society. ½ or 1 unit. Prerequisite: An introductory course in anthropology, sociology, or psychology, or consent of instructor. Bruner.

372. **The Anthropological Study of Art.** A review of the anthropological approach to

art with emphasis on structural analysis and the relationship of the artist to his culture. Problems of stylistic development are considered within the framework of cultural dynamics, and a survey of the major art style areas outside the Western tradition and the Orient is included. ½ or 1 unit. Prerequisite: Three hours of anthropology or consent of instructor. LATHRAP.

373. **Human Development in Cross-Cultural Perspective.** Same as Psychology 373. The comparative analysis of recurrent problems inherent in the biosocial nature of man, particularly as these are reflected in stages of the life cycle from birth through death. Attention is also given to the cross-cultural study of other selected topics such as illness and health, deviancy, and the handling of aggression. Use is made of materials available on the campus in the Human Relations Area Files. ½ or 1 unit. Prerequisite: Six hours of anthropology, sociology, or psychology, or consent of instructor.

374. **Problems in Human Ecology.** Same as Geography, Health Education, Physiology, Psychology, Sociology, and Veterinary Medical Science 374. Methodologies for investigation of problems in human ecology: effects of specific environmental and social factors; multidisciplinary studies of selected current problems. 1 unit. Prerequisite: Anthropology, Geography, Health Education, Physiology, Sociology, or Zoology 369. JACOBS, STAFF.

375. **Peoples and Cultures of the Near and Middle East.** A general survey of the bionomy of the area, followed by a description and analysis of the cultural patterns and social systems of the major ethnolinguistic divisions—Semitic, Iranian, Turkic —and the interrelating function of Islam. Particular consideration given to language, folklore, belles-lettres, music, architecture, crafts, etc., from an anthropological standpoint. Thereafter, selected ethnographies are considered for comparative purposes. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor. ROSEN.

377. **Regional Topics in African Anthropology.** Covers select sociocultural and historical topics of a separate region of Africa (e.g., East, West, Central, South, or North Africa) each time course is taught. Research paper. May be taken a second time only when different region is emphasized. 1 unit. Prerequisite: Consent of instructor. JACOBS, STAFF.

380. **Applied Anthropology.** The contributions of anthropology to modern problems such as the direction and execution of technical assistance programs in nonindustrialized areas of the world, and other cross-cultural contacts involving problems of administration, economic development, and the introduction of new practices and techniques. Designed to be of particular value to those students who expect to carry on technical or professional work among peoples of different cultures in foreign areas or in the United States. ½ or 1 unit. Prerequisite: Six hours of anthropology or sociology, or consent of instructor.

381. **Russian Culture History and Ethnology.** Same as Geography 381. A historical and structural analysis of the development of Russian culture, especially the peasant traditions, from Danubian to contemporary times. ½ or 1 unit. SHIMKIN.

382. **Siberian Culture History and Ethnology.** Same as Geography 382. An ecological analysis of historic and present-day Siberian cultures, with comparisons to Arctic America. ½ or 1 unit. SHIMKIN.

383. **Cultures of Modern East Asia.** Human life in the cultural setting of East Asia since the early nineteenth century. This course centers upon problems of adapting traditions and institutions to the needs of modern industrial civilization; geographical focus varies. 1 unit. Prerequisite: An introductory course in anthropology or East Asian history, or consent of instructor. PLATH.

385. **The Anthropology of Education.** Same as History and Philosophy of Education 385. Introduction to the contribution of anthropology to the cross-cultural study

of education; includes illustrative material from representative cultures ranging from primitive social groups to present-day national states; emphasis is on education as a cultural process in relation to culture change and cultural development. ½ to 1 unit. Prerequisite: A course in anthropology or sociology or consent of instructor.

ARCHITECTURE

(Including Architectural Engineering)

The Department of Architecture offers graduate work leading to the Master of Architecture and Master of Science in Architectural Engineering. Fields of specialization are architectural and urban design (problems in advanced design, analytical studies of selected building types, or investigation of design factors and principles); advanced structural theory and design; architectural administration and building construction; history of architecture.

The prerequisite for graduate study in architecture is a bachelor's degree in architecture equivalent in scope and standards to that of the University of Illinois. The minimum grade-point average for admission to graduate study in architecture is 3.75. Applicants with averages below 3.75 but above 3.5 are considered on an individual basis. Applications from students expecting to register for courses in architectural or urban design must be accompanied by samples of their work in these areas.

Students are expected to follow one of the recommended area programs unless approval is obtained from the chairman of the department for a special program. A minimum of eight units is required for the master's degree.

GRADUATE FACULTY

Professors: J. H. Swing (Chairman of Department), J. S. Baker, L. J. Brightbill, G. T. Clayton, P. H. Coy, W. Eng, G. Guevrekian, H. L. Hornbeak, R. A. Jones, R. D. Katz, A. K. Laing, W. H. Lewis, D. B. Lindsay, R. P. Link, C. B. Looker, A. Notaras, J. G. Replinger, I. Schousboe, R. J. Smith, S. J. Y. Tang, E. F. Toth, A. R. Williams, H. C. Young.

Associate Professors: V. V. Cafourek, E. M. Farnham, S. T. Lanford, C. T. Marfort.

Assistant Professors: L. A. Leffers, F. D. Moyer, J. E. Simon.

COURSES FOR GRADUATES

431. **Advanced Theory of Architecture.** A review of principles of architecture and urban design; factors in programming architectural requirements; design development; analysis and criticism. ½ unit. Prerequisite: Consent of instructor. Williams.

432. **Seminar in Architectural Design.** The analysis and criticism of selected buildings. Individual reports and discussion. ½ unit. Prerequisite: Architecture 431 or consent of instructor. Williams.

435. **Advanced Architectural Design.** Advanced study of space relationships and other elements of architectural design from urban scale to that of individual buildings, including the integration of structural, mechanical, and interior design. Joint studies in urban design with graduate students in urban planning and landscape architecture. 2 units. Prerequisite: Bachelor's degree in architecture (general option) or consent of instructor. Williams.

452. **Advanced Theory and Design of Steel Structures.** Theory and design in bending, buckling, torsion, and combined stresses in beams and columns. Study in de-

sign and behavior of connections; composite constructions; light gauge steel construction analysis. Design and economy of simple and complex building frames. 1 unit. Prerequisite: Architecture 348 or consent of instructor. TANG.

454. Advanced Structural Design in Reinforced Concrete. Critical review of the methods and specifications involved in the design and behavior for flexure, shear, bond, and anchorage; slab-beam-girder, ribbed joist, two-way and flat-slab floor construction; columns and footings; torsion; plastic theory of design; economy and continuity in building design. 1 unit. Prerequisite: Architecture 358 or consent of instructor. TANG.

456. Matrix Methods of Structural Analysis. Use of matrix mathematics and digital computers in the analysis of indeterminate structures by the displacement and force methods. 1 unit. Prerequisite: Computer Science 101, Architecture 347; or consent of instructor.

481. Architectural Practice and the Construction Industry. Analysis of the construction industry and identification of those factors adversely affecting its development. Characteristics of, and relationships among, such components as architectural and engineering services, labor, contractors, manufacturers, building economics, governmental agencies, and research and testing agencies. Experts from these fields are invited to lead discussions on current problems and their solutions, on procedures adversely affecting the industry, and on current and needed areas of research. ½ unit. Prerequisite: Consent of instructor.

491. Special Problems in Architectural Administration and Building Construction. Individual or group research on approved subjects. ½ to 2 units. Prerequisite: Credit or registration in Architecture 481.

493. Special Problems in Structural Theory and Design. Individual or group investigation and study in architectural engineering application. Research in economy and design in correlation with architectural, mechanical, and structural requirements. Options: foundation design; prestressed concrete design; plastic design in steel; structural planning; wood construction; architectural research laboratory. ½ to 4 units. Prerequisite: Consent of instructor. HORNBEAK, TANG, STAFF.

494. Special Problems in Architectural Design. Individual or group investigation of building types, aesthetic problems, and other aspects of architecture. ½ to 2 units. Prerequisite: Architecture 435 or consent of instructor. WILLIAMS, VISITING CRITICS.

496. Special Problems in Architectural History. Individual investigation of the work of particular architects, specific buildings, or the architecture of periods or regions; comparative studies; aesthetic problems. ½ to 2 units. Prerequisite: Architecture 417 or consent of instructor. LAING.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Independent Studies in Urban Design. The individual study of selected topics involving the history, design, and function of significant European cities. ¾ unit. Prerequisite: One year of architecture or history of art; consent of instructor.

310. Ancient Classical Architecture. The development of architecture and urban design in the ancient Greek world and the Roman Empire. ¾ unit. Prerequisite: Architecture 211 and 212, or Art 111 and 112, or consent of instructor.

311. Early Medieval Architecture. The architecture and urban design of the Byzantine Empire, Slavic states, Islam, and Western Europe from the early Christian to the Gothic era. ¾ unit. Prerequisite: Architecture 211 and 212, or Art 111 and 112, or consent of instructor.

312. Gothic Architecture. The development of architecture and urban design in

Europe from the end of the Romanesque period to the Renaissance. ¾ unit. Prerequisite: Architecture 211 and 212, or Art 111 and 112, or consent of instructor.

313. **Italian Renaissance and Baroque Architecture.** The development of architecture, urban design, and garden art in Italy from the early fifteenth century to the late eighteenth century. ¾ unit. Prerequisite: Architecture 211 and 212, or Art 111 and 112, or consent of instructor.

314. **French Architecture, 1500 to 1800.** The development of architecture, urban design, and landscape architecture in France from the early sixteenth century to the late eighteenth century; French influence in the rest of Europe. ¾ unit. Prerequisite: Architecture 211 and 212, or Art 111 and 112, or consent of instructor.

315. **English and American Architecture.** Major architectural developments in Great Britain in the sixteenth, seventeenth, and eighteenth centuries; regional building traditions; sources and development of colonial architecture in America. ¾ unit. Prerequisite: Architecture 211 and 212, or Art 111 and 112, or consent of instructor.

316. **Architecture of the Nineteenth and Twentieth Centuries.** The development of architecture and urban design in Europe and the Americas from 1800 to the present, with special consideration given to the influence of technology and urban conditions. ¾ unit. Prerequisite: Architecture 211 and 212, or Art 111 and 112, or consent of instructor.

317. **The Development of Contemporary Architectural Thought.** An examination of the philosophy of significant architectural writers and architects in relation to their projects and executed work. Those studied include Wright, Gropius, Le Corbusier, Mies van der Rohe, Ruskin, Pugin, Blondel, Laugier, Lodoli, Palladio, Alberti, and Vitruvius. ¾ unit. Prerequisite: Architecture 211 and 212, or Art 111 and 112, or consent of instructor.

337. **Architectural Design.** Continued study of architectural design emphasizing (a) complex site development and composition, and (b) definitive design and refinement of detail for one of the plan components. Preparation of senior thesis program. 2 units. Prerequisite: Architecture 236. Staff.

338. **Architectural Design.** Individual research and comprehensive design solution of a selected architectural project, with special emphasis on site development, integration of structures; mechanical equipment, illumination, and acoustics. 2 units. Prerequisite: Architecture 337. Staff.

339. **Urban Housing.** Study of housing needs, comparative means of financing, comparative building types and costs, and contemporary examples of public and private housing in Europe and the United States. ½ unit. Prerequisite: Consent of instructor. Jones.

344. **Design Development and Construction Documents.** Continued design development and integration of architectural, structural, mechanical, and electrical work for a previously designed student project; application of building codes, production planning, and preparation of general construction working drawings and specifications. No graduate credit. Prerequisite: Architecture 337 or 347.

347. **Theory of Structures.** Advanced problems in the analysis of statically determinate structures; general theories and methods of analysis of statically indeterminate structures; relationships between analysis and design of building frames. 1½ units. Prerequisite: Architecture 257; Mathematics 142. Hornbeak.

348. **Advanced Structures.** Advanced topics on design of structural members and connection. Analysis and design of continuous structures, rigid frames, and tall

buildings. 1½ units. Prerequisite: Architecture 347; credit or registration in Architecture 358. Coy.

358. Advanced Reinforced Concrete. Reinforced concrete building design. 1 unit. Prerequisite: Architecture 247; credit or registration in Architecture 348. Tang.

ART

The Department of Art offers graduate work leading to the degrees listed below.

For admission, an applicant must be a graduate of an accredited college or university with at least a bachelor's degree and with a grade-point average of 3.5 or above; he must be accepted by the graduate committee of the Department of Art after examination of his transcripts, as well as examples of his work if his major is to be in a creative field. Students expecting to major in art education must have (or be eligible for) a teaching certificate in their field. Applicants are expected to have completed an undergraduate program similar to that which leads to the bachelor's degree as established at this University, with a major, or related studies acceptable to the advisers, in the field to be pursued in graduate study.

Normal residence requirement is two years for the Master of Fine Arts and one year for the Master of Arts, although the graduate committee may extend this requirement or increase the unit requirements if this seems warranted.

Complete descriptions of offerings and admission requirements for all degrees and instructions for applying for admission and grants may be had by writing for application forms and the brochure on Graduate Programs in Art, to Warren F. Doolittle, Chairman of Graduate Programs in Art, Department of Art, 140 Fine and Applied Arts Building.

Master of Fine Arts with Design Major (Graphic Design or Industrial Design). Students must complete all the following courses for a minimum of sixteen units: Art 491, one to three units; Art 493, one unit; Art 467 or 477, six to ten units; art history (selected from the group Art 301 through 328), three-fourths unit to one and one-half units; electives or interdisciplinary subjects as determined in consultation with the adviser, two to six units. A thesis is required. Students majoring in graphic design who hold one-half time teaching or research assistantships may expect correspondingly extended residence due to reduced academic load.

Master of Fine Arts with Painting and Printmaking Major. Students must complete all the following courses for a minimum of sixteen units: Art 491, one to three units; Art 493, one unit; Art 495, two to eight units; Art 497, two to eight units, one unit of which must be in intaglio; art history (two courses selected from the group Art 301 through 328), one and one-half units; electives (Art 332, 341, 351, 392, 393, 394, 491, 494; art history and/or other courses approved by the adviser), two to six units. A thesis is required.

Master of Fine Arts with Sculpture Major. Students must complete all the following courses for a minimum of sixteen units: Art 491, one to three units; Art 493, one unit; Art 496, six to ten units; art history (two courses selected from the group Art 301 through 328), one and one-half units; electives (Art 332, 333, 341, 383, 392, 393, 394, 491, 494; art history and/or academic courses approved by the adviser), two to six units. A thesis is required.

Master of Arts with Art Education Major. Students must complete all the following courses for a minimum of eight units: Art 493, one unit; art history (one course selected from the group Art 304 through 328), three-fourths unit; art electives, two and one-fourth units; Educational Psychology 311, one-half unit; Educational Psychology 312, one-half unit; Secondary and Continuing Education 456, one unit; two of the following: History and Philosophy of Education 301, 302, 303, 304, one unit; electives, one unit. No thesis is required. See pages 45 and 46.

Master of Arts with Art History Major. Students must complete all the following courses for a minimum of eight units: Art 493, one unit; Art 494, one unit; art history (courses selected from the groups Art 304 through 328, Art 450 through 454, and Architecture 417 and 496, with the approval of the adviser), three units minimum; Art 499 (thesis), one-half to one unit; electives (Art 492 and/or other courses approved by the adviser), one to three units. Demonstration of proficiency in a modern foreign language (preferably German or French) is also required for the degree.

Doctor of Education in Art Education. The program leading to the Doctor of Education with a major in art education is designed to provide advanced professional preparation for art educators and to develop educational leaders with a high level of art and educational competence. The program is offered jointly by the Department of Art and the College of Education.

Admission. A candidate for admission must hold a master's degree in fine arts, or art education, or the equivalent from an accredited institution. He must also have a minimum of two years' acceptable teaching experience. Admission is determined by examinations administered by the Department of Art and the College of Education, personal interviews, record of previous education and experience, and recommendations from persons who have known the candidate. Examinations administered by the Department of Art include art education, art history, and art processes. Portfolios of art work may also be required.

Applicants for admission should present credentials well in advance of their first registration. Planning a program of study requires that examinations and other steps preliminary to admission be completed prior to the registration period. Admission is not complete until the candidate is accepted by two joint advisers, one from the Department of Art and one from the College of Education.

Residence. Minimum residence requirement is one year of uninterrupted work during which a minimum of six units of work is successfully completed. The remaining course work may be completed during summer sessions or during the regular school year.

Program. A minimum of sixteen units of course work beyond the requirements for the master's degree is required, including six units of credit in art and art education and six units of credit in education. The following courses are required: Elementary Education 455, one unit; History and Philosophy of Education 405 and 410, two units; Educational Psychology 390 and 415, two units; Art 493, one unit; a course in research in art education, one unit; electives in art and art education, three units; electives in education, two units; electives, four units.

A thesis is required, but no academic credit is granted for the thesis. General regulations of the Graduate College covering the filing of the thesis title and the preparation, submission, and publication of the thesis must be met.

GRADUATE FACULTY

Professors: J. R. Shipley (Head of Department), E. H. Betts, C. W. Briggs, C. A. Dietemann, W. F. Doolittle, D. E. Frith, J. W. Kennedy, K. M. Lansing, R. Perlman, E. C. Rae, H. A. Schultz, M. A. Sprague, R. W. Sterkel, R. A. von Neumann, A. S. Weller, E. J. Zagorski, N. Ziroli.

Associate Professors: P. Bodnar, N. McFarland, Ann Perkins, A. R. Sinsabaugh, E. C. Wicks.

Assistant Professors: K. Munakata, Minerva Pinnell.

Instructor: M. Franciscono.

COURSES FOR GRADUATES

450. Studies in Modern Art. Investigation of special problems; writings of artists

and critics; preparation of critical reports. 1 unit. Prerequisite: Consent of instructor.

451. **Studies in American Art.** Investigation of special problems; historical development of the study of American art; techniques of conservation and restoration. 1 unit. Prerequisite: Consent of instructor.

452. **Seminar in Chinese Art.** Investigation of selected phases, concepts, and problems of the art of China; intensive reading and reports. 1 unit. Prerequisite: Art 328 or consent of instructor.

453. **Seminar in Japanese Art.** Investigation of selected phases, concepts, and problems of the art of Japan; intensive reading and reports. 1 unit. Prerequisite: Art 327 or consent of instructor.

454. **Seminar in Ancient Art.** Research seminar in problems selected from the art of ancient Mediterranean area. 1 unit. Prerequisite: At least one of the following: Art 304, 305, 306, 307, or equivalent; reading knowledge of French and German.

467. **Graphic Design Laboratory.** Individually directed research in problems of visual design with emphasis on the understanding of recent developments in nonverbal communication and the utilization of contemporary graphic processes. 1 to 3 units. Prerequisite: Bachelor of Arts or Bachelor of Fine Arts in visual communications or related equivalent.

477. **Industrial Design Laboratory.** Individually directed research in the drafting room or workshop with concentration in industrial design. 1 to 3 units. Prerequisite: Bachelor of Fine Arts in industrial design or equivalent.

491. **Special Problems.** Individual direction in research and in creative activity; thesis. ½ to 2 units.

492. **Individual Readings in History of Art.** Directed readings in special fields or aspects of history of art not provided in depth by the current course offerings. ½ to 1 unit. Prerequisite: Consent of instructor.

493. **Seminar: Introduction to Methods and Criticism.** 1 unit.

494. **Seminar: Studies in the Development of Art History and Criticism.** The relation of art history and criticism; changing standards and criteria; intensive reading of selected critical works; the writing of art criticism. 1 unit. Prerequisite: Consent of instructor.

495. **Painting Laboratory.** Professional and experimental painting with emphasis on the development of maturity of style and personal expression. ½ to 3 units.

496. **Sculpture Laboratory.** Experience at a professional level in sculptural techniques including metals casting, welding, stone carving, wood carving, clay modeling, and ceramic sculpture, with emphasis on the development of creative achivement. 1 to 3 units. Prerequisite: Graduate standing in art and permission of the departmental graduate committee.

497. **Print Workshop.** Intaglio, relief, and planographic; printing, including etching, engraving, aquatint, wood, paper and plastic relief printing, and lithography. ½ to 3 units.

499. **Thesis Research.** Guidance in research and writing theses for advanced degrees. 0 to 4 units. Prerequisite: Graduate standing in history of art.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Greek Painting.** Vase paintings, wall paintings, mosaics, and other examples of the graphic art of the Greek world from Mycenaen times through the Hellenistic period. ¾ unit. Prerequisite: Consent of instructor.

302. **Art of the Ancient Near East.** Focuses on Egypt and Mesopotamia and deals to a lesser degree with the more peripheral or eclectic arts of Persia, Syria-Palestine, and Anatolia. The period extends from the late prehistoric age to the time of Alexander the Great. ¾ unit. Prerequisite: Consent of instructor.

303. **Art of the Eastern and Western Roman Empire.** Deals with monuments outside Italy both in the eastern and western parts of the Empire. The influence of native traditions and the development of local styles is emphasized. ¾ unit. Prerequisite: Art 307 or any course in Roman art or archaeology; consent of instructor.

304. **Greek Sculpture.** A survey of the development of Greek sculpture from Mycenean times to the Christian Era with analysis of the major works in relief and in the round. ¾ unit. Prerequisite: One year of art history or consent of instructor.

305. **Art of the Augustan Age.** A study of the major works of architecture, sculpture, and painting in Italy and the Roman Empire from the time of Augustus, ¾ unit. Prerequisite: One year of art history or consent of instructor.

306. **Near Eastern and Greek Art.** Architecture, sculpture, and painting of Egypt, Western Asia, Crete, and of Greece from Mycenean times through the Classical period. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

307. **Hellenistic, Roman, and Byzantine Art.** Architecture, sculpture, painting, and mosaics of the Hellenistic world, Italy and the Roman empire, and the Byzantine empire. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

308. **Early Medieval Art.** The arts of Byzantium and of Western Europe from the early Christian through the Romanesque period. ¾ unit. Prerequisite: One year of history of art.

309. **Gothic Art.** The arts of Western Europe from the end of the Romanesque period until the Renaissance. ¾ unit. Prerequisite: One year of history of art.

310. **The History of Printmaking.** The development of the various graphic processes in the hands of important printmakers from the fifteenth through the nineteenth centuries. ½ or ¾ unit. Prerequisite: One year of history of art or consent of instructor.

313. **Italian Renaissance Art.** Architecture, painting, sculpture, and minor arts of Italy during the Renaissance. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

314. **Northern Renaissance Art.** Architecture, painting, sculpture, and minor arts of France, Germany, Spain, and England in the sixteenth, seventeenth, and eighteenth centuries. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

315. **Art of the Nineteenth Century.** Architecture, painting, sculpture, and minor arts of the nineteenth century in France, Germany, Spain, and England. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

316. **Later Chinese Painting.** A study in depth of later phases of Chinese painting, particularly that of the Ming and Ch'ing dynasties; connoisseurship in Chinese painting. ¾ unit. Prerequisite: Art 328, or a course in Chinese history of the period covered, or consent of instructor.

318. **Latin-American Art.** Study of the more important phases and periods of the visual arts of Latin America. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

319. **Italian Art of the Seventeenth and Eighteenth Centuries.** An examination of the arts of painting, sculpture, and architecture of the seventeenth and eighteenth centuries in Italy in terms of major figures and dominant stylistic tendencies. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

320. **Northern European Art of the Seventeenth and Eighteenth Centuries.** An examination of major developments in painting, sculpture, and architecture in the Low Countries, France, Spain, and England during the seventeenth and eighteenth centuries, in terms of major figures and dominant stylistic developments. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

321. **Twentieth-Century Art, 1900 to 1925.** Study of the leading personalities and movements in Western painting, sculpture, and architecture, with emphasis on the first. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

322. **Twentieth-Century Art, 1925 to Date.** Study of the leading personalities and movements in Western painting, sculpture, and architecture, with emphasis on the first. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

323. **American Art to 1840.** Architecture, painting, sculpture, and minor arts of the Colonies and the United States to 1840. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

324. **American Art, 1840 to 1900.** Architecture, painting, sculpture, and minor arts of the United States. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

325. **Recent American Painting and Sculpture.** Current developments, with special emphasis on works shown in contemporary exhibitions at the Krannert Art Museum. ½ or ¾ unit. Prerequisite: One year of history of art or consent of instructor.

326. **Art of Medieval Japan.** A study of Japanese art, primarily painting, from the thirteenth century, with emphasis on the work of individual artists. ¾ unit. Prerequisite: Art 327, or a course in Japanese history of the period covered, or consent of instructor.

327. **Japanese Art.** History of Japanese art from earliest times to the twentieth century. ¾ unit. Prerequisite: One year of history of art or junior standing.

328. **Chinese Art.** History of Chinese art from earliest times to the present. ¾ unit. Prerequisite: One year of history of art or junior standing.

330. **Cinematography.** Theory and practice of motion pictures as an art form. Emphasis is on individual creative production. ½ to 1 unit; may be repeated to a maximum of 2 units. Prerequisite: Art 215.

332. **Drawing.** Advanced drawing in several media. ½ to 1 unit. Prerequisite: Art 126 or equivalent; for graduate students, consent of departmental graduate committee.

333. **Painting.** Advanced painting in oil and other media. Not open to candidates for the Master of Fine Arts in painting and printmaking. ½ to 1 unit; may be repeated for a total of 2 units. Prerequisite: Art 142 or equivalent; for graduate students, consent of departmental graduate committee.

341. **Painting Materials and Techniques.** Study of the materials and techniques used in the various media: oil, watercolor, tempera, gouache, encaustic, etc. ½ unit. Prerequisite: Art 142 or graduate standing in art.

351. **Advanced Sculpture Techniques.** Advanced work in various sculptural media. ½ to 1 unit. Prerequisite: Art 252 or equivalent.

383. **Print Media.** Advanced work in various printmaking techniques. Not open to candidates for the Master of Fine Arts in painting. ½ to 1 unit. Prerequisite: Art 284 or equivalent; for graduate students, consent of departmental graduate committee.

385. **Lithography.** Laboratory course in lithography. Course of study includes a complete development of the process, exploiting its potential as a fine art medium.

½ to 1 unit. Prerequisite: Art 286; for graduate students, consent of departmental graduate committee.

392. Silversmithing, I. Advanced course in design and execution of hollowware, dealing primarily with raising and spinning methods and with the decorative processes of chasing, repoussé, niello, filigree, and inlay. ½ to 1 unit. Prerequisite: Consent of instructor.

393. Silversmithing, II. Advanced course in design and execution of flatware and hollowware, dealing primarily with forging and seaming methods, engraving, and toolmaking. ½ to 1 unit. Prerequisite: Consent of instructor.

394. Ceramic Design. Ceramic design with emphasis on the development of professional style and personal expression. ½ to 2 units. Prerequisite: Art 295 or consent of instructor.

ASIAN STUDIES

A graduate minor in Asian studies is administered by the Center for Asian Studies in cooperation with various departments. It is possible for a graduate student electing this minor to concentrate on East Asia, Southeast Asia, South Asia, or the Near and Middle East, or a combination of two or more of these areas.

A candidate for a master's degree who elects Asian studies as a minor must earn at least two units of graduate credit in at least two departments from approved courses.

A doctoral candidate who elects Asian studies as a minor must earn at least four units of graduate credit in at least two departments from approved courses.

The list of the courses which may be chosen to satisfy the minor in Asian studies is available at the Center for Asian Studies, 1207 West Oregon Street, Urbana.

Also, the doctoral candidate must, prior to the completion of his course requirements for the degree, complete satisfactorily one of the following: Arabic 304, Burmese 304, Chinese 304, Hindi 304, Indonesian 304, Japanese 304, or equivalent.

Candidates should contact the Director of the Center for Asian Studies regarding additional courses which would be acceptable.

Students who do not elect an Asian studies minor but who seek knowledge of Asian affairs, cultures, and languages are invited to consult, either directly or through their advisers, with the Director of the Center or with faculty associated with the Center in order to develop programs suited to their individual needs.

The adviser for the graduate minor is Professor Solomon B. Levine, Director of the Center for Asian Studies, 1207 West Oregon Street, Urbana.

ASTRONOMY

The Department of Astronomy offers graduate work leading to the Master of Science and Doctor of Philosophy in Astronomy (including radio astronomy). Admission requires a minimum grade-point average of 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis. In addition, the normal entrance requirements are as follows: (1) a bachelor's degree in astronomy, physics, electrical engineering, or mathematics, and (2) a one-year course in descriptive astronomy.

The eight units for the Master of Science may be obtained in three ways, listed as (1), (2), and (3) below. Alternative (3) is intended for students wishing to specialize in radio astronomy.

(1) All eight units may be taken in astronomy; at least three units must be at the 400 level.

(2) Two units may be selected from approved courses in mathematics; two units may be taken in approved courses in physics; the remaining units must be taken in

astronomy. At least three units must be at the 400 level, and at least two of these three units must be taken in astronomy.

(3) Five units may be earned by taking Physics 341, 342, Electrical Engineering 420, 421, and Astronomy 357. The remaining three units must be taken in astronomy; only one of these units need be at the 400 level.

Details regarding the Doctor of Philosophy may be obtained by writing to the Head of the Department, University of Illinois Observatory.

For information regarding applied mathematics, see page 285.

GRADUATE FACULTY

Professors: G. C. McVittie (Head of Department), G. W. Swenson, Jr., S. P. Wyatt, K. M. Yoss.

Associate Professors: J. H. Cahn, J. R. Dickel, J. B. Kaler, E. C. Olson.

COURSES FOR GRADUATES

401. Stellar Atmospheres. Physical characteristics of stellar atmospheres as derived from spectroscopic observations; radiation transfer, theory and observations of the continuous spectrum, limb darkening; formation of absorption lines, line profiles, curves of growth, relative chemical abundances; emission features; forbidden radiation. 1 unit. Prerequisite: Consent of instructor. Kaler.

403. Gaseous Nebulae and the Interstellar Medium. Distribution, structure, and spectra of nebulae; physical processes in planetary and diffuse nebulae; recombination, fluorescence, and forbidden line radiation; determination of physical parameters; nature of the interstellar medium; interstellar gas and grains; observation of interstellar medium. 1 unit. Prerequisite: Astronomy 301. Kaler.

404. Theory of Stellar Structure. Masses, luminosities, radii, and surface temperatures of stars; basic equations and stability conditions; nuclear reactions; integration of basic equations; results—initial stages, later stages, white dwarfs. 1 unit. Prerequisite: Consent of instructor. Olson.

415. Experimental Methods in Radio Astronomy. Design and construction of instruments for radio astronomy; techniques of observation of celestial radio sources; interpretation of data. 1 unit; may be taken a second time for credit. Prerequisite: Consent of instructor. Dickel, Swenson.

424. Relativity and Cosmology. Same as Mathematics 460 and Physics 424. Elements of tensor calculus and Riemannian geometry; special relativity; Lorentz transformations, equivalence of mass and energy; general relativity and the gravitational field of the sun; galaxies and cosmology. 1 unit. Prerequisite: Consent of instructor. McVittie.

433. Solar System Astrophysics. Planetary orbits and perturbations; physical perturbations; physical parameters of the planets; planetary interiors, atmospheres, magnetospheres, and surface layers; the satellites; asteroids and comets; meteors, meteorites, and tektites; interplanetary grains and gas; problems of origin and evolution. 1 unit. Prerequisite: Consent of instructor. Dickel, Wyatt.

486. Constitution of the Ionosphere: An Introduction to Aeronomy. Same as Electrical Engineering 486. Properties of the neutral and ionized atmosphere above 60 km. height, and the photochemical processes causing them; diffusion of ionospheric constituents; solar and meteoric perturbations of the ionosphere. 1 unit. Prerequisite: Graduate standing in electrical engineering, physics, or astronomy; Mathematics 341 or equivalent. Bowhill.

491. Seminar in Special Topics. 1 to 4 units. Prerequisite: Consent of instructor. Staff.

499. Thesis Research. 0 to 3 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Introductory Astrophysics. Stars, observational data and their determination; atoms and radiation; stellar atmospheres; equilibrium of stellar interiors; special types of stars, interstellar matter. 1 unit. Prerequisite: Physics 108. OLSON.

302. Astrophysics of the Sun. Observations of the sun at all wave lengths and application of the results to the study of the photosphere, chromosphere, and corona; structure of the atmosphere of the quiet sun; solar activity. 1 unit. Prerequisite: Astronomy 301. DICKEL.

306. Foundations of Mechanics and Gravitational Theory. Same as Aeronautical and Astronautical Engineering 306. Introduction to the dynamics of particles and rigid bodies with special emphasis on elementary planetary motion, motion of a rocket, motion of long-range projectile relative to Earth, precession of Earth's axis, etc. 1 unit. Prerequisite: Mathematics 142 or 143. AVNER.

307. Celestial Mechanics. Two-body problem; Kepler's equation; planet's orbit in space; distance in solar system; gravitational potential; perturbations in planetary motion; dynamical theory of stars of high velocity; spiral arm of galaxy. 1 unit. Prerequisite: Astronomy 306 or Physics 322. AVNER.

314. Observational Astronomy. Same as Civil Engineering 305. Astronomical coordinate systems and transformations; theory of, and practice in, approximate and precise determinations of latitude, longitude, and time; introduction to theory of errors; theory and practice of astronomical photography. 1 unit. Prerequisite: Astronomy 102 or 210, or Civil Engineering 201; Mathematics 142 or 143. WYATT.

315. Observational Techniques and Reductions. Methods of observation and reductions in photographic and photoelectric photometry, spectrophotometry, and stellar radial velocity determinations. 1 unit. Prerequisite: Astronomy 314. Yoss.

317. Elements of Magnetohydrodynamics. Same as Aeronautical and Astronautical Engineering 317. Equations of magnetohydrodynamics, single-fluid and multiple-fluid models, magnetic interaction parameters, magnetosonic waves, hydromagnetic shock waves, aligned-field and crossed-field flows, theory of characteristics, MHD accleration, generation, and propulsion. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 213 and 216 or consent of instructor. BOND.

321. Stellar Systems, I. Galactic structure: the observational data; stars in the solar neighborhood; the solar motion; stellar statistics and distribution; stellar populations; interstellar matter and spiral structure; the whole galaxy. 1 unit. Prerequisite: Astronomy 102 or 210; Physics 108. Yoss.

322. Stellar Systems, II. Continuation of Astronomy 321. Galactic dynamics: stellar motions; galactic rotation; dynamics and mass distribution; stellar encounters; dynamics of interstellar matter. Galaxies: distances, structural features; groups and clusters; radio galaxies and quasars; spatial distribution and motions. 1 unit. Prerequisite: Astronomy 321. WYATT.

357. Radio Astronomy. Same as Electrical Engineering 357. Instrumental theory and observational technique; radar and meteors; the moon and planets; solar radio waves; galactic and extragalactic radio astronomy. 1 unit. Prerequisite: Physics 108. DICKEL.

366. Aeronomy: Physics of the Upper Atmosphere and Space. Same as Electrical Engineering and Physics 366. Structure and composition of the Earth's upper atmosphere, solar radiation and its interaction with the upper atmosphere; the ionospheric layers; planetary atmospheres; airglow and aurora; interplanetary plasma; the magnetic field of the Earth and its interaction with the solar plasma;

experimental techniques. 1 unit. Prerequisite: Physics 321, 342, and 381; or consent of instructor. RAETHER.

BIOCHEMISTRY

Biochemistry is a multidisciplinary field resulting from an interaction of chemistry and physics with biology. The biochemistry staff offers training in biochemistry, or molecular biology and biophysical chemistry (see below and also page 103). Programs leading to graduate degrees in biochemistry are offered in the Biochemistry Division of the Department of Chemistry and Chemical Engineering. Entering graduate students in biochemistry must therefore meet the graduate entrance requirements of that department (see page 101).

Interested students should contact the Biochemistry Division.

BIOLOGY

See descriptions and course listings under Life Sciences, page 244.

BIOPHYSICS AND BIOPHYSICAL CHEMISTRY (MOLECULAR BIOLOGY)

Biophysics is a rapidly growing field that cuts across many disciplines. An area overlapping with this and developing through interaction of chemistry and biology is that of biophysical chemistry.

Since graduate study in biophysics and biophysical chemistry involves several areas of biological and physical sciences, the Graduate College has adopted a flexible system enabling students to enter special interdisciplinary programs in these areas, thus affording them a wide range of opportunity for study and research in borderlands between the biological and physical sciences.

For the program leading to the Doctor of Philosophy in Biophysics, see descriptions and course listings under Life Sciences, pages 256 and 260.

Students majoring in chemistry or microbiology may elect to specialize in biological problems at the molecular level (see pages 103 and 253). Students in other areas of the biological and physical sciences who wish to arrange programs of study emphasizing biophysics should direct their inquiries to the head of the major department.

BOTANY

See descriptions and course listings under Life Sciences, page 244.

BUSINESS

The Doctor of Philosophy in Business is awarded to those who complete the subject matter requirements listed below and the general requirements outlined in the first section of this catalog. The subject matter requirements represent primarily a carefully selected group of subjects offered in the several fields of the College of Commerce and Business Administration.

Candidates for the degree should have a training such as that represented by graduation from an accredited college of commerce or school of business. Students

who have not graduated from such college or school or from an institution offering an equivalent program must present a minimum of thirty hours in commerce subjects, including at least one course in each of the following: accountancy, economics, management, and marketing. Those candidates who hold a master's degree in economics or business can usually complete the requirements in two years by synchronization of courses previously taken with those offered in this program.

In lieu of the usual major and minor requirements for the doctorate, candidates for the Doctor of Philosophy in Business must prepare themselves for examination in five fields. Two of these, management and economic theory, are required, but the other three are elective. One of the elective fields may be outside the College of Commerce and Business Administration and must include at least two units. Within these requirements it is expected that each student will select, in consultation with his adviser, an individual program of study to meet his specific needs and objectives. For numbers and titles of courses available, see the listings in this catalog under accountancy, business education, economics, finance, industrial administration, and marketing.

Because the major fields for this degree cross departmental lines, administration of the work is supervised by a committee. A doctor's dissertation constitute the work of the third graduate year. Correspondence relating to the degree should be addressed to the Chairman of the Committee on the Doctor of Philosophy Degree in Business, 360 Commerce and Business Administration Building (West).

COURSES FOR GRADUATES

499. Thesis Research. 0 to 4 units.

BUSINESS ADMINISTRATION

The Graduate School of Business Administration offers professional programs in business administration leading to the degrees of Master of Business Administration, Doctor of Business Administration, Master of Accounting Science, and Master of Commerce.

Master of Business Administration. The Master of Business Administration program is designed primarily for students whose undergraduate preparation is in liberal arts and sciences, engineering, or other nonbusiness areas. Students whose undergraduate preparation is in business may apply for admission, and the make-up of programs of those admitted is frequently adjusted to account for the special preparation of the degree candidate. The M.B.A. program requires a minimum of sixteen units (or sixty-four semester hours) of course work. No thesis is required. Candidates are admitted in September and February.

Doctor of Business Administration. Applications for the Doctor of Business Administration program should have completed their master's program in the upper one-half of their master's class. A minimum of eight units of professional courses beyond the master's degree is required. Candidates who have earned a master's degree from one-year programs are required to complete a minimum of sixteen units of course work. Candidates are admitted in September, February, and June.

Master of Commerce. The Master of Commerce program is designed specifically for students whose undergraduate preparation is in business. Candidates for the Master of Commerce degree are required to take an evaluation examination upon entering the program. This examination covers the equivalent of the first-year M.B.A. program. An outstanding performance on this examination permits granting of the Master of Commerce degree after completion of eight units of course work. Normally, a candidate who is well prepared in the several areas of business administration is required to complete twelve to fourteen units of work.

Master of Accounting Science. For details of this program, see Accountancy, page 51.

Additional information concerning the requirements of the various degree programs may be obtained from the Graduate School of Business Administration, 350 Commerce and Business Administration Building (West).

COURSES FOR GRADUATES

500. Business Economics. Analysis of supply and demand functions in an uncertain environment; practical applications of economics to the management of business enterprise; the firm's place in the economic system; the place of the enterprise in national accounts. Case materials are used. ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

501. Managerial Economics. Monetary and national income analyses essential to understanding governmental policies directed to macro-economic goals; the impact of such policies on the individual business firm and on decision-making by business management; the responsibilities of the individual business firms in contributing to the attainment of social goals of a macro-economic nature; the role of the business leader in formulating public policy in the macro-economic area. ¾ unit. Prerequisite: Business Administration 500 or equivalent.

510. Administrative Behavior. This course focuses on the problems faced by an administrator in an interpersonal setting. Primary emphasis is on the analysis of individual and group behavior in a union and nonunion work setting and the determination of actions which the administrator can take to promote desired work performance. Extensive use is made of theory and research related to individual and group behavior to aid in the diagnosis of problems covered. Students take part in either laboratory or field studies. ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

511. Business Organization. An analysis of business organization. Major emphasis is on the processes of allocation, coordination, and communication, making decisions about organizations under conditions of certainty and uncertainty for optimal performance, and measures of organizational preformance. Critical examination of factors involved in choosing either a centralized or a decentralized style of organization. ¾ unit. Prerequisite: Business Administration 510.

512. Business Organization and Its Environment. An analysis of business organizations adapting to shifts in internal and external elements. Major emphasis is on (1) the business firm as a part of a complex socio-economic system; (2) the effects of government, labor unions, and political, religious, and business organizations on the executive's decision problems; (3) environmental factors conducive to organizational change; and (4) organizational growth. ¾ unit. Prerequisite: Business Administration 511.

513. Seminar in Organization Theory. This course examines the major types of organization theory. Use of organization theory to guide research and to make business decisions; examination of major research methods used to study business organizations. ¾ unit. Prerequisite: Business Administration 512.

520. Marketing. An introductory analysis of the marketing system, its operations, and the mechanisms for coordinating these operations. The relationships of the firm to other firms and other institutions in the marketing system are studied, and the effects that such relationships have on the nature of decision problems of the individual business are analyzed. The firm's problem in developing an integrated marketing program, and the specific problem areas of price, channel, location, sales, and market development are discussed. ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

522. Quantitative Analysis for Marketing Decisions. The development of analytic

quantitative models of various aspects of the firm's marketing environment and of models of marketing decision problems is studied. The course also involves a study of the ways in which such models can be used as a basis for making marketing decisions. Topics include market measurement, estimation of various kinds of market data, identification of the relationships between marketing variables, and forecasting. ¾ unit. Prerequisite: Business Administration 520 or equivalent.

524. **Market Development.** Communication from manufacturers and middlemen to consumer and industrial users, and from manufacturers to middlemen, is an essential element in the marketing process. The course deals with management of the several components of the market communication function including personal selling, advertising, sales promotion, and some marketing aspects of public relations activities for both consumer and industrial goods. Management of the market communication function is studied through cases dealing with (1) determining market communications goals and policies; (2) creating an organization to perform the market communication function; (3) planning market communication operations, including problems such as planning a sales campaign, selecting advertising media, setting standards and coordinating advertising with personal selling, and dealer promotions; (4) stimulating personnel and controlling execution of the plans; and (5) evaluating results obtained from specific selling activities. ¾ unit. Prerequisite: Business Administration 522 or equivalent.

525. **Product Management.** This course deals with the decisions on the firm's total market offer, including such topics as (1) use of market analysis in making decisions on assortment, product development, pricing, packaging, branding, and sales forecasting, and (2) coordination of these decisions and actions with market communications, physical movement, production, finance, and the over-all goals and policies of the firm. The use of analytic and research methods in making assortment and product decisions is emphasized. ¾ unit. Prerequisite: Business Administration 522 or equivalent.

527. **Seminar in Marketing Theory and Policy.** This seminar is designed to study theories relating to the marketing system and the role of the individual business firm within that system. Marketing policy problems are discussed within the framework of various aspects of the firm's environmental circumstances. Marketing planning and decision-making processes covered include those involved in choice of policy concerning the marketing mix, price and product strategy, market development, and social and governmental relations. ¾ unit. Prerequisite: Business Administration 524 or 525.

531. **Introduction to Production.** An introductory course in decision-making problems in production. The course includes the theoretical foundations for production management as well as the applications of decision-making techniques to production problems in the firm. In particular, production processes, plant layout, maintenance, scheduling, quality control, and production control are considered. ¾ unit. Prerequisite: First semester of the M.B.A. program.

532. **Production Planning and Control.** Decision-making topics in production at the factory manager level and above are treated in depth. Topics include the development of generalized decision rules and systems analysis in production. In particular, the design of production control, quality control, and inventory control systems are stressed, and each of these systems is integrated into the firms as a whole. ¾ unit. Prerequisite: First year of the M.B.A. program.

533. **Quantitative Techniques in Production.** An advanced course in the application of quantitative techniques to decision-making problems dealing with production in the firm. Topics include structural estimation of production systems, application of operations research techniques to production problems, and computer simulation of decision systems. ¾ unit. Prerequisite: Business Administration 532 or equivalent.

540. **Written Analysis, I.** To develop the student's ability in writing reports based upon analysis of cases and the conclusions reached, this course has a threefold objective: (1) to improve the student's capacity to express himself effectively and efficiently in writing; (2) to contribute to the sharpening of his analytic skills; and (3) to help him integrate the knowledge learned in the functional fields. ½ unit. Prerequisite: Registration in the Graduate School of Business Administration.

541. **Written Analysis, II.** The first part of this course is devoted to the scientific method of inquiry and specific research techniques. The purpose is to study both elements of basic logic and research procedures in order to help the student evaluate the reliability of data and validity of conclusions contained in business reports. The second part of the course is devoted to a major field study. Each student develops a solution to a business problem and presents an oral and written report of the solution to both the faculty and the businessmen concerned. ½ unit. Prerequisite: Business Administration 540 or equivalent.

542. **Business and Society.** The position of the business enterprise as an institution in American society; the role of the businessman in that society. ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

543. **Legal Problems of Business Management.** Past and current development of the legal climate in which business operates and in which managerial decisions are made; growth of the common law with its system of courts and procedure for law enforcement; the law of contracts, including various devices available for protection of creditors; legal problems involved in selecting a form of business organization. Students analyze business problems to see the importance of proper applications of the law to managerial decisions in regard to business policies. ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

544. **Executive Policies and Planning.** A course on policy construction at the executive level and the planning aspects of policy implementation. Builds a general management point of view. Study of company-wide situations from the vantage point of the chief executive. Case method study with supporting readings. Develops integration and application of the subject matter of prior courses. 1 unit. Prerequisite: Completion of first year of the M.B.A. program or equivalent.

545. **Business Logistics.** Movement, distribution, and control of raw materials and finished goods; site selection for manufacturing, warehousing, and distribution facilities; transportation media, selection, inventory control, communications networks, and requirements for logistics control data. Emphasis is on developing an integrated logistics system for a company. ¾ unit. Prerequisite: Enrollment in second year of the M.B.A. program or consent of instructor.

551. **Financial Analysis.** An introduction to the subject of managerial finance, with emphasis on basic decisions of management and provision of capital resources. Techniques of profit planning and forecasting, evaluation of financial performance relative to control standards, and development of criteria for commitment of funds are stressed. ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

552. **Financial Management and Control, I.** An analysis of the tools and techniques of capital expenditure management, with emphasis on the relation of financial forecasting and control to criteria for investment planning and asset management. The theory of investment is examined, as well as the relation of organizational structure to capital planning policy. ¾ unit. Prerequisite: Business Administration 551.

553. **Financial Management and Control, II.** An analysis of the problems confronting corporate financial management in deciding appropriate methods of financing

capital expenditure commitments. A thorough analysis of the specialized literature, coupled with the use of selected case material, forms the core of the course. ¾ unit. Prerequisite: Business Administration 552.

554. **Financial Theory and Policy.** Special problems of economic analysis and their relation to the functional discipline of managerial finance; includes study of techniques for forecasting financial requirements under uncertainty, problems of income determination, the relation of long-term capital commitments to uncertain payoff vectors, internal and external capital rationing, and problems of identifying capital supply functions. ¾ unit. Prerequisite: Business Administration 553, 573, and 576.

557. **Seminar in Finance.** Analysis of (1) financial policies and problems connected with corporate expansion through acquisition of interest in, or absorption of, established concerns including an examination of the legal, economic, and financial background for business combination, or (2) specific problems of financial management in light of differing operating characteristics of major enterprise classifications, including opportunities for students to construct decision models for application to problems of financial management. ¾ unit. Prerequisite: Business Administration 554 and 573.

560. **Managerial Accounting and Control.** An analysis of managerial controls, the information needed for their operation, and the manner in which accounting provides that information; emphasis upon accounting as a tool of management. Problems and cases stress the type of figure information relevant to managerial decisions, and the methods of using such data. ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

562. **Industrial Cost Control.** A study of cost accounting, with emphasis on the use of operating data by management for control purposes. Methods of material pricing, labor costs, including fringe benefits; indirect manufacturing costs, direct costing, standard costs; estimated and statistical costs; distribution costs; contribution to overhead theory; depreciation and replacement of equipment; selection of plant; decision to make or buy; relation between costs and pricing policy. ¾ unit. Prerequisite: Business Administration 560 or equivalent.

563. **Controllership.** The controller in the business organization: his property control responsibilities; internal check; internal audits; insurance; his assistance to operating management through budgeting, break-even analysis, profitability studies; his relationship with groups outside of management such as investors and government agencies; emphasis on manner in which figure function of controller is used to integrate the operations of the business enterprise. ¾ unit. Prerequisite: Business Administration 562 or equivalent.

570. **Mathematical Analysis for Business Decisions.** The use of classical mathematics in business decision-making; development of the concepts of total and marginal value analysis. Special emphasis is placed on the construction of quantitative models of business and economic systems, topics in bivariate and multivariate functions, differentiations, and integration. ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

571. **Decision Theory.** Application of finite mathematics to business decision-making; an introduction to the theory of sets; partitions and counting; vectors and matrices, as well as Bayesian statistics. Major emphasis is placed on linear programming and the theory of games. ¾ unit. Prerequisite: Registration in the Graduate School of Business Administration.

572. **Modern and Classical Statistics for Business Decisions.** The application of classical and modern statistics for business decision-making; topics in probability distributions, variance analysis, and partial and multiple correlation analysis as

well as the use of personal probabilities and utility theory. ¾ unit. Prerequisite: Business Administration 571.

573. **Introduction to Operations Research.** An introduction to operations research techniques; topics in integer, nonlinear, and dynamic programming, queueing theory, replacement, and Monte Carlo techniques; special projects in game theory applications in business. ¾ unit. Prerequisite: Business Administration 572; completion of first year of the M.B.A. program.

574. **Application of Operations Research Techniques.** The application of the operations research techniques developed in Business Administration 573 to practical business problems. Most of the semester is devoted to a series of field research studies. Prior to the field studies, a review of previous work in the field is made. The role of the computer in solving operations research problems, as well as its application to the field research, is also a major consideration. ¾ unit. Prerequisite: Business Administration 573.

575. **Business Simulation.** An introduction to the use of computers in solving business problems. Topics include the relation of integrated data processing systems to information flows within the firm and the development of simulation models of intrafirm decision processes. ¾ unit. Prerequisite: Business Administration 573.

576. **Business Forecasting and Econometrics.** An introduction to maximum likelihood estimating techniques. Topics include the use and limitations of least squares, two-stage least squares, limited-information and full-information estimates. Problems with observational errors, multi-colinearity, and auto-correlation in time-series and cross-section structural estimation are considered. A major portion of the course is devoted to the application of the econometric techniques in business forecasting and analysis. ¾ unit. Prerequisite: Business Administration 572.

582. **International Business Operations, I.** An integration of economics and the functional areas of business focused on the problems of managing international business operations. Economic, legal, functional, and administrative problems are studied through cases and literature emphasizing financial and marketing problems. Students select one of Europe, Latin America, Africa, Middle and Near East, or South Asia and Far East, for special study and reporting. ¾ unit. Prerequisite: Completion of first year of the M.B.A. program.

583. **International Business Operations, II.** Continuation of Business Administration 582. ¾ unit. Prerequisite: Business Administration 582.

590. **Independent Study and Research.** Directed reading and research. ½ or 1 unit.

599. **Thesis Research.** Individual direction of research and thesis writing. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

373. **Electronic Data Processing for Business.** A course in the fundamentals of business data processing. The use of modern electronic computers in the areas of accountancy, economics, management, marketing, and general business is considered. The facilities of the Digital Computer Laboratory are utilized in the course. ½ or 1 unit. Prerequisite: Economics 170; Accountancy 166 or 108. Hinomoto, Nolan.

CERAMIC ENGINEERING

The Department of Ceramic Engineering offers work leading to the Master of Science and Doctor of Philosophy in Ceramics or in Ceramic Engineering. The prerequisite for graduate study in these areas is proficiency in the undergraduate

courses required for the Bachelor of Science in Ceramic Engineering at the University of Illinois, or acceptable equivalents.

A minimum grade-point average of 3.75 for the last sixty hours of undergradaute work is required for admission. Students with grade-point averages between 3.75 and 4.0 are considered on an individual basis. Students who have bachelor's degrees in chemistry, physics, geology, or engineering may become candidates in this department.

A candidate for the Master of Science in Ceramics or Ceramic Engineering must complete a minimum of eight units of graduate work including a thesis.

Candidates for the Doctor of Philosophy in Ceramics must present the equivalent of the courses in chemistry, mathematics, physics, and ceramics listed in the undergraduate engineering curriculum.

Candidates for the Doctor of Philosophy in Ceramics or Ceramic Engineering are required to complete first the M. S. thesis (or give equivalent evidence of research); they must also pass the departmental qualifying examination.

Minors selected by graduate students in ceramics or ceramic engineering are chemistry, physics, mathematics, geology, or other engineering disciplines.

Students majoring in chemistry, physics, engineering, and other departments may take sole or second minors in ceramics or ceramic engineering. A second minor requires no ceramics prerequisite.

GRADUATE FACULTY

Professors: A. L. Friedberg (Head of Department), A. W. Allen, C. G. Bergeron, R. L. Cook, J. A. Nelson, V. J. Tennery, F. V. Tooley.

Associate Professors: S. D. Brown, W. S. Williams, T. A. Willmore.

COURSES FOR GRADUATES

401. Ceramic Chemistry. Silica, silicates, fusions, and phase relations. 1 unit. Prerequisite: Courses in chemistry and physics.

402. Ceramics. Chemical and physical phenomena. 1 to 2 units. Prerequisite: Courses in physics and chemistry.

405. Glass Technology. This course, following a brief review of unit processes and operations in glass manufacture, treats from a dominantly theoretical and research point of view selected major topics relating to the glass preparation process and the chemical, mechanical, optical, and electrical properties of glass. ¾ or 1 unit; for students electing the course for 1 unit, extra contact hours are arranged. Prerequisite: Ceramic Engineering 301 or equivalent, or consent of instructor. Tooley.

406. Glass Technology. This course is dominantly theoretical in approach. Following a survey of the basic theoretical ideas that have been used in the development of the glass model, student readings and reports from the classical and modern literature serve as the basis of class discussions on glass structure and behavior, with emphasis on structure property correlations. ¾ or 1 unit; for students electing the course for 1 unit, extra contact hours are arranged. Prerequisite: Ceramic Engineering 405 or consent of instructor. Tooley.

407. Porcelain Enamels. This course covers the fundamental scientific principles involved in the area of porcelain enameling and the properties of such coatings. 1 or 1½ units (includes laboratory if taken for more than 1 unit). Prerequisite: Ceramic Engineering 222 and 320, or equivalent.

409. Whitewares. Advanced study in the field of whitewares, including fundamental considerations of glazes and all types of ceramic bodies. Special emphasis is placed on new developments in research and processing. Considerable attention is given to the ferroelectric and ferromagnetic properties of electronic ceramics. 1 or 1½

units (includes laboratory if taken for more than 1 unit). Prerequisite: Ceramic Engineering 309; Ceramic Engineering 340 or equivalent. Cook.

410. **Dielectric Properties of Ceramic Materials.** Fundamental properties of vector fields are reviewed. The reaction of insulating solids to external electric fields is considered in terms of dielectric theory. The properties of ceramic dielectrics including ferroelectrics are treated in terms of present theory. The piezoelectric properties of ferroelectric crystals and ceramics are correlated with the crystal structure, microstructure, and the ferroelectric properties. ¾ or 1 unit; for students electing the course for 1 unit, extra contact hours are arranged. Prerequisite: Mathematics 345 and 343, or consent of instructor. Tennery.

412. **Structural Physical Ceramics.** Structural chemistry and crystallization behavior of ceramic systems at elevated temperatures; nucleation, crystal growth; mineral synthesis; high-temperature reaction kinetics, including phase transformations and diffusion. ¾ or 1 unit; for students electing the course for 1 unit, extra contact hours are arranged.

414. **Physicial Chemistry of Clays and Soils.** Same as Agronomy and Mining Engineering 414. The application of physical chemical principles and concepts to surfaces and adsorption on surfaces. Silicate surfaces and water adsorption are emphasized. 1 unit. Prerequisite: Chemistry 340 and 341, or equivalent, or consent of instructor.

421. **High-Temperature Technology.** A review of the methods of achieving and controlling high temperatures, both in industrial processes and in the laboratory, combined with a study of the techniques for measuring the properties of materials at elevated temperatures emphasizing oxides, carbon and graphite, silicates, carbides, borides, silicides, nitrides, sulfides, cermets, and refractory metals. A correlation of the physical and chemical behavior of these materials with their crystal structure, microstructure, and physical form is emphasized where possible. ¾ unit. Prerequisite: Ceramic Engineering 310. Allen.

422. **High-Temperature Technology Laboratory.** Laboratory to accompany Ceramic Engineering 421, with emphasis on instrumentation for and measurement of properties at elevated temperature. Analytical interpretation of data in numerical problems is included. ½ unit. Prerequisite: Credit or registration in Ceramic Engineering 421, or consent of instructor. Allen.

461. **Mineralogy of Clays.** Same as Geology 461. The composition of various types of clays; the structure and properties of the clay minerals; the origin and mode of occurrence of the clay minerals and clay materials. 1 unit. Prerequisite: Geology 336 or Chemistry 328, or equivalent; consent of instructor. Grim.

462. **Mineralogy of Clays.** Same as Geology 462. The properties of clay materials, their relation to the structure of the clay minerals, methods of determination and control; the utilization of clays in various arts and industries. 1 unit. Prerequisite: Geology 461. Grim.

495. **Materials and Special Problems.** Conference and laboratory. 0 to 2 units.

499. **Thesis Research.** Research in any of the branches of ceramics. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Advanced Chemistry and Technology of Glass.** This course augments some of the subject matter of Ceramic Engineering 214, and develops additional subject matter relating to the theory of glass formation and structure and the behavior of glass as a function of composition, structure, and heat treatment. Students taking this course gain improved qualifications for research work in the field. ½ unit. Prerequisite: Ceramic Engineering 214 or consent of instructor. Tooley.

307. **Thermal and Mechanical Properties of Ceramic Materials.** Interpretations of the thermal and mechanical behavior of real ceramic materials utilizing the atomistic concepts of structure correlated with characterized microstructure. Half of the course treats the mechanism of thermal dilatation, heat transport and emission. The remainder integrates the characterization of deformation including elastic, anelastic, plastic, and viscous behavior. Temperature dependency is stressed throughout. Lectures and laboratory. ¾ unit. Prerequisite: Ceramic Engineering 216, 331, or equivalent; Theoretical and Applied Mechanics 154 and 221. Brown.

309. **Whiteware Materials.** A study of the characteristics and engineering properties of multi-phase polycrystalline aggregates and vitreous complexes including the raw material preparation, fabrication, and processing. Special emphasis is placed on the single and multi-oxide component bodies, including the crystallographic structures of the alkaline earth titanates and the ferritic spinels as whiteware materials. ¾ unit. Prerequisite: Ceramic Engineering 216 or equivalent. Cook.

310. **Refractory Technology.** A study of the engineering properties and thermochemistry of polycrystalline materials for use at elevated temperatures, including processing of raw materials, the manufacture, heat treatment, quality control, and specification of refractory products. Particular emphasis is placed on oxides, silicates, carbides, borides, cermets, and refractory metals, with a correlation of the properties of those materials to certain design criteria. ¾ or 1 unit (includes laboratory if taken for 1 unit). Prerequisite: Ceramic Engineering 307. Allen.

311. **Ceramic X-Ray Analysis.** The use of x-ray diffraction for phase identification, for the determination of crystalline lattice parameters, and for the determination of the thermal expansion of crystalline solids is discussed; analytical methods of indexing powder diffraction patterns are covered; the determination of precise lattice parameters by means of computer programming and high temperature x-ray techniques is reviewed. ¾ unit. Prerequisite: Mathematics 195; senior standing in the Departments of Engineering, Chemistry and Chemical Engineering, or Geology, or consent of instructor. Tennery.

320. **Advanced Porcelain Enamels.** An advanced study of the field of porcelain enamels with particular emphasis on fundamentals of bond or adherence of enamel metal systems, on opacity and mechanism of color development and measurement, and on the thermal and chemical properties of coatings on metal. Specific attention is given to coatings for use on metals at elevated temperatures. ½ or ¾ unit. Prerequisite: Ceramic Engineering 222 or consent of instructor. Cook.

331. **Ceramic Microscopy.** A study of the optical activity in isotropic and anisotropic media with particular emphasis on the materials and products of ceramics; the application of these principles and related topics of optical microscopy to the study of the morphology, aggregation, size, and microstructure of the products of high-temperature thermochemical reactions and equilibria. ¾ or 1 unit (includes studies in thermal microscopy if taken for 1 unit). Prerequisite: Ceramic Engineering 205 and 216, or consent of instructor. Allen.

340. **Electrical Ceramics.** The subject of dielectric crystals and their electrical properties is presented; the ferroelectric and piezoelectric properties of several crystal classes are discussed and correlated; the perovskite class of ferroelectric compounds is covered in detail; spinel, garnet, and hexagonal type ferrimagnetic crystals and their properties are discussed. ¾ unit. Prerequisite: Ceramic Engineering 309 or consent of instructor. Tennery.

CHEMICAL PHYSICS

Fundamental research on many properties of molecular and solid state systems is based on an understanding of chemistry, physics, and mathematics that can best be

obtained by training in more than one department of the University. A program leading to the Doctor of Philosophy in Chemical Physics makes it possible for students to gain the necessary background and perform original research in this interdisciplinary field of science.

Applicants for admission should have undergraduate degrees in chemistry or physics, a grade-point average of at least 4.0, and a strong background in the major field of chemistry or physics, with more than the usual training in the other area. Those who received their degrees in physics should have the equivalent of one semester each of organic and inorganic chemistry and one year of physical chemistry. Those who received their degrees in chemistry should have the equivalent of one semester each of intermediate mechanics and intermediate electricity and magnetism. One year of mathematics beyond calculus is recommended. Deficiencies should be removed during the first year of study.

In addition to satisfying the requirements of the Graduate College, students must pass either the qualifying examination in the Department of Physics or the set of cumulative examinations given by the Division of Physical Chemistry. A knowledge of the content of Chemistry 348 and 349 or Physics 362 and 381 must be demonstrated also (for example, by passing the final examinations in these courses).

Research for the dissertation is performed under the direction of staff members who are currently active in chemical physics. Students may apply for fellowships and assistantships and may make use of the facilities available in the Departments of Chemistry and Chemical Engineering and Physics.

Students with undergraduate degrees in chemistry should direct inquiries and applications to the head of the Department of Chemistry and Chemical Engineering; students with undergraduate degrees in physics should direct inquiries and applications to the head of the Department of Physics.

CHEMISTRY AND CHEMICAL ENGINEERING

The degrees offered in chemistry and chemical engineering are Master of Arts or Master of Science in Chemistry, Master of Science in Chemical Engineering, and Doctor of Philosophy in Chemistry or in Chemical Engineering. Attention is also called to a joint program leading to the Doctor of Philosophy in Chemical Physics (see page 101) and to the program in Biophysical Chemistry (see pages 92, 103, and 253).

Students who have fulfilled the usual undergraduate course requirements, including at least twenty-five semester hours in chemistry properly distributed, and who have a grade-point average of 4.0 or above, may apply for admission to the Graduate College in chemistry or chemical engineering. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

Students who have completed graduate work in chemistry or chemical engineering at another institution may be admitted if they have grade-point averages of 4.0 in both undergraduate and graduate work, or if they have earned a 4.25 average in at least eight units or a full year of graduate work at an accredited institution.

Graduate students whose major subject in the Graduate College is in a department other than Chemistry and Chemical Engineering may take chemistry courses for graduate credit if they have had the equivalent of fifteen semester hours of chemistry. Such students are advised to consult members of the staff in choosing courses appropriate to their backgrounds and objectives.

MASTER OF SCIENCE IN THE TEACHING OF CHEMISTRY

Candidates for the Master of Science in the Teaching of Chemistry must earn four units in chemistry, two units in education, and two units of electives in either education or physical science. The two units in education consist of the following courses: History and Philosophy of Education 304 and 305, and Educational Psychology 311 and 312. The courses in chemistry and the electives, which must normally

give graduate credit, must be selected with the approval of the adviser. Students applying for admission must have a grade-point average of at least 3.5. Inquires concerning this program should be directed to Professor Don Secrest, 155 Noyes Laboratory.

CHEMICAL ENGINEERING

Candidates for advanced degrees in chemical engineering should have had undergraduate training comparable to that offered in the undergraduate chemical engineering curriculum at the University of Illinois. Students who enter without the usual engineering courses are required to make up their deficiencies to the extent prescribed by their adviser. Candidates for the Master of Science must include two chemical engineering courses at the 400 level in their programs.

BIOCHEMISTRY

The Biochemistry Division of the Department of Chemistry and Chemical Engineering administers the graduate program in biochemistry. The curriculum is composed of Chemistry 350, 355, 450, 452, and 494 (same as Microbiology or Biophysical Chemistry 494), and selected offerings in allied chemical and biological areas. Interested students are invited to contact the biochemistry staff.

BIOPHYSICAL CHEMISTRY

The Department of Chemistry and Chemical Engineering offers an area of specialization in biophysical chemistry. The program is flexible and provides the student with basic training in physical chemistry, physical biochemistry, and biology. Students electing this area should have a solid background in physics and mathematics. Details of the curriculum are decided individually.

GRADUATE FACULTY

Professors: H. S. Gutowsky (Head of Department), D. E. Applequist, J. C. Bailar, Jr., H. P. Broquist, T. L. Brown, H. E. Carter, D. Y. Curtin (Associate Head of Department), R. S. Drago, H. G. Drickamer, W. H. Flygare, I. C. Gunsalus, L. P. Hager, G. P. Haight, Jr., T. J. Hanratty, J. P. Hummel, H. A. Laitinen, N. J. Leonard, H. V. Malmstadt, R. A. Marcus, J. C. Martin, T. Moeller, R. F. Nystrom, J. A. Quinn, K. L. Rinehart, H. R. Snyder, S. Swann, Jr., G. Weber, J. W. Westwater, P. E. Yankwich.

Associate Professors: J. E. Baldwin, P. Beak, R. L. Belford, J. M. Clark, A. M. Hartley, R. S. Juvet, R. A. Schmitz, G. J. Schroepfer, Jr., D. H. Secrest, S. G. Smith.

Assistant Professors: W. R. Bauer, J. K. Beattie, V. A. Bloomfield, R. M. Coates, H. E. Conrad, R. G. Denning, C. A. Eckert, J. Goodisman, J. L. Hudson, J. Jonas, J. R. Lombardi, I. C. Paul, W. H. Pirkle, R. L. Sani, G. D. Stucky, L. J. Todd, J. M. Wood, R. W. Woody, J. T. Yardley.

Chemistry

COURSES FOR GRADUATES

402. **Inorganic Chemistry.** The less familiar elements and their relationship in the periodic system. Lectures, reports, and assigned readings. 1 unit.

404. **Advanced Inorganic Chemistry Laboratory.** Specialized laboratory techniques; more difficult inorganic syntheses. ¼ to ¾ unit. Prerequisite: Credit or registration in one of the lecture courses in inorganic chemistry in the 400 series.

405. **Inorganic Chemistry.** Seminar. Required of all graduate students whose major is inorganic chemistry. ¼ unit.

406. **Physical Inorganic Chemistry.** Qualitative description of the bonding in inorganic compounds; use of physical methods to provide information about the structure and reactions of inorganic compounds; structures and reactions of inorganic compounds in solution. 1 unit. Prerequisite: Chemistry 315 and 344.

407. **Special Topics in Inorganic Chemistry.** Discussions of newly developing areas of inorganic chemical research. ¼ to 1 unit. Prerequisite: Graduate standing in chemistry. KAY.

408. **The Chemistry of Complex Inorganic Compounds.** The nature of the coordinate bond; applications of complex compounds. 1 unit. Prerequisite: Chemistry 315.

421. **Spectrochemical Methods of Analysis.** Emission spectroscopy; Raman spectroscopy; mass spectrometry; ultraviolet, visible, infrared, and microwave absorption spectroscopy; colorimetry, fluorimetry, interferometry, and polarimetry. Lectures and laboratory. 1 unit. Prerequisite: General physics and chemistry equivalent to a major for a bachelor's degree.

422. **Electrical Methods of Chemical Analysis.** Polarography, potentiometric, amperometric, conductometric titrations, and other selected topics. Lectures and laboratory. 1 unit. Prerequisite: Chemistry 344 or equivalent.

423. **Electron Microscopy.** Same as Biology 423. Lectures, discussions, and demonstrations on the physical principles and electron optics of the transmission of electron microscopes and its modern variants, including lectures and demonstrations of modern high vacuum techniques. Open to qualified graduate students in all departments. ½ unit. Prerequisite: A course in modern physics or physical chemistry (having calculus as a prerequisite) affording an introduction to wave mechanics, or consent of instructor.

424. **Quantitative Analysis.** Advanced principles, including chemical statistics, calculations, experimental methods, and applications. ½ unit.

425. **Analytical Chemistry.** Seminar. Required of all graduate students whose major is analytical chemistry. ¼ unit.

427. **Applied X-Rays: Crystallography.** Lectures. ¾ unit. Prerequisite: Training in physics and physical chemistry.

429. **Electron Microscopy with Laboratory.** Same as Biology 429. General lectures on theory and design of electron microscopes without mathematical derivations; discussion and practice on specimen preparation; operation of electron microscopes with separate sections to meet special needs of biologists, geologists, and those interested in electron diffraction. (Most theory lectures may be omitted by those enrolled or having credit in Biology or Chemistry 423). Open to qualified graduate students in all departments. 1 unit. Prerequisite: Two semesters of general physics, two semesters of college mathematics, and three semesters of chemistry, or consent of instructor.

430. **Organic Chemistry.** Survey of organic chemistry for graduate students. 1 unit. Prerequisite: One year of organic chemistry.

431. **Organic Chemistry.** Advanced survey of organic chemistry with emphasis on reaction mechanisms and synthesis. 1 unit. Prerequisite: Chemistry 430 or 336; one year of physical chemistry.

432. **Organic Chemistry.** Advanced survey of organic chemistry with emphasis on structure. 1 unit. Prerequisite: Chemistry 431 or 336.

433. **Organic Chemistry.** Special topics in organic chemistry. An advanced course dealing with a subject not ordinarily covered by regularly scheduled courses, such as natural product synthesis and biosynthesis, organic photochemistry, chemistry of special families of organic compounds, etc. ½ or ¾ unit; ¾ unit requires two lectures per week. Students may repeat this course for credit. Prerequisite: Chemistry 431 and 432, one of which may be taken concurrently.

434. **Advanced Organic Synthesis.** Lecture and laboratory. ¼ to 1 unit.

435. **Organic Chemistry.** Seminar. Current literature in organic chemistry. ½ unit. Prerequisite: Consent of instructor.

436. **Experimental Organic Chemistry.** A lecture course on research techniques in organic chemistry. ¼ unit. Prerequisite: Consent of instructor.

440. **Physical Chemistry.** Survey of physical chemistry for graduate students. 1 unit. Prerequisite: Consent of instructor.

441. **Chemical Thermodynamics.** Fundamental laws of thermodynamics and their molecular interpretation; determination and chemical use of thermodynamic quantities. 1 unit. Prerequisite: Chemistry 342 and 344, or equivalent.

442. **Statistical Thermodynamics.** Basic principles of classical and quantum statistics with applications to chemistry. 1 unit. Prerequisite: Chemistry 441 and 446, or consent of instructor.

445. **Physical Chemistry.** Seminar. Required of all graduate students whose major is physical chemistry. ¼ or ½ unit. Prerequisite: Consent of instructor.

446. **Quantum Chemistry, I.** An introduction to quantum mechanics: basic theory and methods of approximations; applications to atomic systems. 1 unit. Prerequisite: Chemistry 349 and Mathematics 388, or equivalent; consent of instructor.

447. **Quantum Chemistry, II.** Continuation of Chemistry 446. Application of quantum mechanics to chemical problems; theories of the chemical bond; structure and spectra of molecules. 1 unit. Prerequisite: Chemistry 446 or equivalent; consent of instructor.

448. **Chemical Kinetics.** Chemical reaction and theory of rate processes. Lectures. ¾ unit. Prerequisite: Chemistry 441 or consent of instructor.

449. **Special Topics in Physical Chemistry.** An advanced course dealing with a subject not ordinarily covered by regularly scheduled courses, such as molecular spectroscopy, statistical mechanics, radiation and hot-atom chemistry, molecular quantum mechanics, radiofrequency spectroscopy, advanced experimental methods, kinetics of irreversible processes and cooperative phenomena, etc. Students may register for credit more than once. ½ or 1 unit. Prerequisite: Consent of instructor.

450. **Chemistry of Biological Processes.** A consideration at the molecular level of biological processes including bioenergetics, biosynthetic and degradative pathways of cellular components, metabolic regulation and enzyme reaction mechanisms. 1 unit. Prerequisite: Chemistry 350 and 355.

452. **Experimental Techniques in Biochemistry.** Experiments on the isolation, purification, and analysis of biological material, including proteins and enzymes. Methods of studying constituents of biological material; their degradation products, and the metabolic processes, including the isolation and characterization of intermediates. ¾ or 1 unit. Prerequisite: Chemistry 350 and 355.

455. **Biochemistry.** Seminar. Discussions of current research and literature. Required of all graduate students whose major is biochemistry. ½ unit. Prerequisite: Chemistry 350 and 355, or equivalent.

493. **Advanced Electron Microscopy.** Same as Biology 493. Conferences and practice

dealing with specialized laboratory techniques, preparation of specimens, the analysis and study of varied materials by use of transmission and/or scanning electron microscopes and by the techniques of electron diffraction. Open to qualified students in all departments. ¼ to ½ unit. Prerequisite: Credit in Biology or Chemistry 429 and consent of instructor.

494. **Chemical Basis of Biological Specificity.** Biological formation and interaction of large molecules; analysis of the structural features concerned with functional specificity in heteropolymers, viruses, and subcellular particles; nucleic acids and their role as genetic molecules; proteins in their role as genetic products with highly specific functions; metabolic interrelations of these molecules. ¾ unit. Prerequisite: Chemistry 344, 346, and 350, or 450; Microbiology 330; or consent of instructor.

496. **The Use of Carbon-14 in Labeling Techniques.** Same as Animal Science 496. A comprehensive study of the chemistry of carbon-14. The laboratory work deals with vacuum-line manipulations and synthesis, degradation, and assay of radioactive carbon compounds. ¾ or 1 unit. Prerequisite: Chemistry 336, 337, and 338, or equivalent; consent of instructor.

499. **Thesis Research.** A candidate for the master's degree who elects research is required to present a thesis. A thesis is always required of students working toward the Doctor of Philosophy. Not all candidates for thesis work necessarily are accepted. 0 to 4 units. Work may be taken in any of a wide variety of fields, subject to the approval of an appropriate staff member who serves as the student's thesis adviser.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

315. **Inorganic Chemistry.** Nuclear and extranuclear atomic structures and their relation to the properties of the elements and their compounds; types of bonding; survey of the periodic relationships; preparation and applications of the elements and their compounds. ¾ unit. Prerequisite: Credit or registration in physical chemistry.

316. **Inorganic Chemistry.** Preparation of typical inorganic compounds illustrating special and more advanced techniques. ½ unit. Prerequisite: Credit or registration in Chemistry 315.

321. **Chemical and Instrumental Analysis.** Chemical and instrumental methods of analysis and their application to the quantitative study of chemical reactions. ¾ to 1¼ units. Prerequisite: Chemistry 336 and 340 or 342 with registration in Chemistry 343 and 344. STAFF.

322. **Analytical Separations and Experimental Design.** Quantative study of separations by chemical and instrumental analytical methods. Application of statistics to separation methods, to experimental design, and to interpretation of experimental data. ¾ unit. Prerequisite: Chemistry 321 or equivalent.

323. **Applied Electronics for Scientists.** A lecture and laboratory course designed expressly for chemists and other scientists or engineers who have little or no background in electronics, but who need a working knowledge of electronic devices, circuits, and instruments. The course begins with electronic principles and leads systemmatically into digital, analog, and servo systems used in scientific instrumentation. 1 unit. Prerequisite: Consent of instructor.

336. **Organic Chemistry.** Second course. Lectures and recitations. ¾ unit. Prerequisite: Chemistry 133 with a grade of A or B, or Chemistry 234.

337. **Organic Chemistry.** Laboratory experiments in organic chemistry. ½ unit. Prerequisite: Credit or registration in Chemistry 336.

338. **Systematic Identification of Organic Compounds.** 1 unit. Prerequisite: Chemistry 336 and 337, or equivalent.

339. **Theoretical Organic Chemistry.** Theoretical interpretation of reactivity, reaction mechanisms, and the nature of common reaction intermediates: carbonium ions, free radicals, and carbanions. ¾ unit. Prerequisite: Chemistry 338 or consent of instructor.

340. **Principles of Physical Chemistry.** A one-semester course in physical chemistry emphasizing topics most important to students in the biological and agricultural sciences. Not open to students in the specialized curricula in chemistry or chemical engineering. 1 unit. Prerequisite: Physics 102; Chemistry 122 and 133, or equivalent; Mathematics 132 or equivalent.

341. **Elementary Physical Chemistry Laboratory.** A laboratory course to accompany Chemistry 340. ¼ unit. Prerequisite: Registration in Chemistry 340 or credit for one semester of a lecture course in physical chemistry.

342. **Physical Chemistry.** This course and Chemistry 344 constitute a year-long study of chemical principles, covering topics such as: atomic and molecular structure, properties and thermodynamics of gases, liquids, crystals, phase equilibria, solutions, surface chemistry, chemical equilibrium, electrochemistry, chemical thermodynamics, and chemical kinetics. Students who do not intend to take Chemistry 344 should not enroll in Chemistry 342. ¾ unit. Prerequisite: Chemistry 108, 122, 123, or equivalent; Physics 106, 107, and 108, or two semesters of general physics with concurrent registration in the third semester; credit or registration in Mathematics 142 or equivalent. STAFF.

343. **Physical Chemistry Laboratory.** Quantitative experimental study of chemical principles. Chemistry 343 and 345 constitute a year-long introduction to experimental physical chemistry. These courses may be taken consecutively or concurrently. ¼ unit. Prerequisite: Chemistry 342. STAFF.

344. **Physical Chemistry.** Continuation of Chemistry 342. ¾ unit. Prerequisite: Chemistry 342. STAFF.

345. **Physical Chemistry Laboratory.** Continuation of Chemistry 343. May be taken concurrently with Chemistry 343. ¼ unit. Prerequisite: Chemistry 342; credit or registration in Chemistry 343 and 344. STAFF.

346. **Physical Chemistry of Macromolecules.** The physical properties of systems containing large molecules, with special emphasis on proteins and high polymers; the use of physical methods for the characterization of such substances. ¾ or 1 unit (laboratory required for one unit). Prerequisite: Chemistry 340 or 344; consent of instructor.

348. **Advanced Physical Chemistry.** The sequence Chemistry 348 and 349 is designed to give seniors and graduate students a unified treatment of physical chemistry on an advanced level. Topics discussed are the electronic structure and spectra of atoms, principles of wave mechanics, experimental and theoretical aspects of the chemical bond in diatomic and polyatomic molecules, statistical thermodynamics, and chemical kinetics. 1 unit. Prerequisite: Chemistry 344 or equivalent.

349. **Advanced Physical Chemistry.** Continuation of Chemistry 348. 1 unit. Prerequisite: Chemistry 348.

350. **General Biochemistry.** The chemistry and reactions of constituents of living matter, including carbohydrates, lipids, proteins, nucleic acids, vitamins, coenzymes, and minerals; the chemistry and regulation of the reactions and processes of whole organisms, plant and animal, of organs, cells, and subcellular particles and soluble components. Lectures and assigned readings. ¾ unit. Prerequisite: Quantitative analytical chemistry, and Chemistry 133 or 234, or equivalent.

351. Physicochemical Basis f Biochemistry. An introduction to the physico-chemical methods and ideas underlying biochemistry. ¾ unit. Prerequisite: Chemistry 340, or equivalent, or consent of instructor.

354. Introduction to Biochemistry. Lectures: Structure and function of living matter, with emphasis on the mammalian organism. Laboratory: The isolation, chemical characterization, and function of the structural and catalytic components of living cells. This course is designed primarily to meet the needs of veterinary medicine, nutrition, dietetics, and other professional students. Open to other students only by special permission when space is available. This course does not meet the requirements for registration in advanced courses in biochemistry. 1 unit. Prerequisite: Quantitative analytical chemistry, and Chemistry 133 or 234, or equivalent; laboratory course in general biology, botany, or zoology; or consent of instructor.

355. Biochemistry Laboratory. To accompany Chemistry 350. An introduction to experimentation with biochemical systems, processes, and compounds of biochemical importance; identification and quantitative measurement of constituents and transformations in biological systems. Laboratory, quizzes, and assigned readings. Required of all students who expect to take advanced courses in biochemistry. ¾ unit. Prerequisite: Quantitative analytical chemistry, and Chemistry 133 or 234, or equivalent; registration in Chemistry 350.

383. Dynamics, Structure, and Physical Methods. A laboratory course presenting the relationship of dynamics and structure with emphasis on the use of physical methods to follow the course of reactions. ½ unit. Prerequisite: Registration in Chemistry 342; Chemistry 234 and 281; credit or registration in Physics 108 and Mathematics 142.

385. Chemical Fundamentals. A laboratory course with experiments on the fundamental physical nature of chemical phenomena. 1 unit. Prerequisite: Registration in Chemistry 344; Chemistry 342 and 383.

392. Applied X-Rays. Generation and detection of x-rays, absorption and scattering of x-rays by matter; crystals, crystal and molecular symmetry; techniques of x-ray diffraction; identification and analyses; deduction of atomic positions. ¾ unit. Prerequisite: Chemistry 342 or consent of instructor.

394. Applied X-Ray Laboratory. Techniques of x-ray analysis; powder techniques; fluorescence analysis; Weissenberg, precession camera techniques; reduction of film data; determination of crystal structure. ¼ to 1 unit. Prerequisite: Credit or registration in Chemistry 392, or consent of instructor.

395. History of Science with Particular Reference to Chemistry. ½ unit. Prerequisite: Twenty hours of laboratory science.

396. Atomic Physics. Same as Physics 381. A lecture and problem course presenting our modern knowledge of the nature and properties of electrons, light quanta, atoms and molecules. Topics discussed include evidence for the atomic nature of matter, the properties of free electrons and ions, photons and their interaction with matter, atomic spectra and structure, molecular spectra and structure, and an introduction to the ideas of quantum mechanics. 1 unit. Prerequisite: General physics and Mathematics 343 or 345. It is recommended that chemistry majors take Chemistry 344 before registering in this course; concurrent registration in Physics 385 is also recommended.

397. Radiochemistry. Same as Nuclear Engineering 397. Properties of radioactive nuclei, nature of radioactivity, nuclear structure, nuclear reactions, interactions of radiations with matter, chemical aspects of radioactivity work, and applications of nucleonics to chemistry. ¾ unit. Prerequisite: One semester of physical chemistry or one semester of atomic physics or consent of instructor.

398. Radiochemistry Laboratory. Same as Nuclear Engineering 398. To accompany Chemistry 397. Radioactivity detection and tracer applications of radioisotopes

in chemistry and other fields. Laboratory and discussions. ½ unit. Prerequisite: One semester of physical chemistry or one semester of atomic physics or consent of instructor.

Chemical Engineering

COURSES FOR GRADUATES

464. **Transport Phenomena.** Analysis of the various phenomena associated with transport processes; mechanism and phenomenological description; equations of change; interphase transport. Application to systems involving the transfer of energy, mass, and momentum. 1 unit. Prerequisite: Mathematics 345 or 343; Chemical Engineering 373 or consent of instructor.

465. **Chemical Engineering.** Seminar. Required of all graduate students whose major is chemical engineering. ¼ unit. Prerequisite: Chemical Engineering 373.

466. **Applied Mathematics in Chemical Engineering.** The development of mathematical models and a survey of modern mathematical methods currently used in the solution of chemical engineering problems. Topics include the application of vectors and matrices, partial differential equations, numerical analysis, and methods of optimization in chemical engineering. ¾ or 1 unit. Prerequisite: Consent of instructor.

468. **Properties of Fluids.** The kinetic theory of gases and the prediction of transport coefficients; statistical mechanics applied to dense gases and liquids; theories of solutions. ¾ or 1 unit. Prerequisite: A background in modern physical chemistry and physics; consent of instructor.

469. **Special Topics in Chemical Engineering.** Various advanced topics are covered from time to time. These are generally taken during the second year of graduate study. Typical topics include turbulence, hydrodynamic instability, process dynamics, interfacial phenomena, reactor design, properties of matter at high pressure, phase transitions. ¾ or 1 unit. Prerequisite: Chemical Engineering 464.

487. **Fluid Dynamics.** Basic concepts in fluid dynamics with special emphasis on topics of interest to chemical engineers. Derivation of the Navier-Stokes equations; solutions for creeping flow, for perfect fluids, and for boundary layers; non-Newtonian fluids; turbulence. 1 unit. Prerequisite: Chemical Engineering 464.

488. **Advanced Topics in Heat and Mass Transfer.** Principles of transfer operations developed in terms of physical rate processes. Boundary layer heat and mass transfer, eddy diffusion, phase changes, and separation processes. ¾ or 1 unit. Prerequisite: Chemical Engineering 464 or consent of instructor.

499. **Thesis Research.** Candidates for the master's degree who elect research are required to write a thesis. A thesis is always required for the Doctor of Philosophy. Not all candidates for thesis work necessarily are accepted. Any student whose major is in another department must receive permission from the head of the Department of Chemistry and Chemical Engineering to register in this course. 0 to 4 units. Drickamer, Eckert, Hanratty, Hudson, Quinn, Sani, Schmitz, Swann, Westwater.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

363. **Introduction to Process Engineering.** Same as Food Science 363. Fundamentals of heat transfer, fluid flow, evaporation, drying, and other unit operations in the process industries. For students in chemistry, engineering, and food science; not open to majors in chemical engineering. Lectures and problems. ¾ unit. Prerequisite: Calculus or consent of instructor.

367. **Introduction to Process Control.** An introduction to the control of industrial chemical processes. Lecture and laboratory. ¾ unit. Prerequisite: Mathematics 345 or 343; Chemical Engineering 371.

368. **Chemical Engineering Kinetics.** Principles of reaction kinetics and applications to reactor design. ¾ unit. Prerequisite: Chemical Engineering 370.

370. **Chemical Engineering Thermodynamics.** The fundamental concepts and laws of thermodynamics. Primarily for students in chemical engineering. ½ unit. Prerequisite: Chemical Engineering 261; Chemistry 342.

371. **Principles of Chemical Engineering.** Introduction to fluid dynamics and heat transfer. Lectures, problems, and quizzes. 1 unit. Prerequisite: Chemical Engineering 370 or consent of instructor.

373. **Principles of Chemical Engineering.** Introduction to mass transfer operations. Lectures, problems, and quizzes. 1 unit. Prerequisite: Chemical Engineering 371.

374. **Unit Operations Laboratory.** To accompany Chemical Engineering 373. Laboratory and computations in the unit operation. ½ unit. Prerequisite: Credit or registration in Chemical Engineering 373.

377. **Process Dynamics.** The basic ideas of process dynamics and their applications in chemical engineering. ¾ unit. Prerequisite: Chemical Engineering 367 or consent of instructor.

379. **Chemical Engineering Projects.** Laboratory. Development of an individual project. ½ unit. Prerequisite: Senior standing in chemistry or chemical engineering.

380. **Heat, Mass and Momentum Transport.** A unifying treatment of physical rate processes with particular emphasis on the formulation and solution of typical boundary value problems associated with heat, mass, and momentum transport. ¾ unit. Prerequisite: Mathematics 343 or 345; Chemical Engineering 371; or consent of instructor.

381. **Chemical Engineering Plant Design.** Comprehensive problems, lectures, and discussion on plant design and the economic factors involved in design and operation of chemical plants. ½ unit. Prerequisite: Chemical Engineering 373.

382. **The Prediction of Physical Properties.** The prediction of equilibrium and transport properties in gases, liquids, and solids. ½ unit. Prerequisite: One year of physical chemistry.

CIVIL ENGINEERING

(Including Sanitary Engineering)

The Department of Civil Engineering offers a combination of advanced study and participation in creative research to meet the needs of individual students. Such graduate training prepares students to assume greater responsibilities and to contribute to the progress of the civil engineering profession. Graduate study and research can be pursued in the fields of air pollution; analysis and design of structures; behavior of structures and properties of structural materials (concrete, steel, and other materials); construction engineering and management; digital computer applications to analysis or design; geodetic engineering; health physics; highway engineering; hydrology; hydromechanics and hydraulic structures; materials and structural design of roadways; models research; nuclear structural shielding; photogrammetry and photogrammetric engineering; radiological health; railway engineering; rock mechanics; soil mechanics and foundations; stream analysis; structural dynamics; design for earthquake, shock, and blast excitation; structural mechanics; systems analysis and design; traffic engineering; transporation planning; systems design and operations;

urban planning and management; waste water treatment; water quality and treatment; and water resources.

The department is presently engaged in a substantial building program which will reach completion in several phases. The first phase houses the concrete structures, portions of the metal structures, soil mechanics, and sanitary engineering groups. Later additions to the building will provide for others in the department's educational and research activities. These new laboratories have extensive facilities for the study of the fundamental behavior of structures and structural materials under static or dynamic, and repeated loads, and for the study of various environmental conditions found in the sanitary engineering and science fields.

The Master of Science and Doctor of Philosophy in Civil Engineering may be attained by qualified students who satisfy the requirements of the department and the Graduate College. Progress toward an advanced degree is measured not only by the accumulation of units of credit in formal course work but also by evidence of intellectual growth and achievement. A prerequisite for graduate work in civil engineering is the equivalent of the undergraduate courses required for the Bachelor of Science in the branch of the subject in which registration is desired.

The Master of Science and Doctor of Philosophy are offered in Sanitary Engineering. The prerequisite for admission to the first year of graduate study is a Bachelor of Science in Engineering or in one of the physical or life sciences.

Admission to the Graduate College with full status in civil or sanitary engineering is granted to graduates of institutions whose requirements for the bachelor's degree are substantially equivalent to those of the University of Illinois, provided the applicant's preparation is appropriate to advanced study in his chosen major field and his scholastic average is at least 4.0. Under certain conditions, applicants with a grade-point average of less than 4.0, and applicants from schools with different grading systems, may be considered if their average is equivalent to or higher than 3.75 and evidence is submitted indicating that the applicant's ability is not appropriately measured by the grades submitted.

Because of the wide range of interests in graduate work in the Department of Civil Engineering, there are no specific course prerequisites for a major in the department. The requirements for a major or a minor must be approved by the head of the department.

A minimum of eight units must be completed for the master's degree when a thesis is included. If a thesis is not included, nine units are required.

A pamphlet entitled *Graduate Study and Research in Civil and Sanitary Engineering* is available upon request to the Head, Department of Civil Engineering.

GRADUATE FACULTY

Professors: N. M. Newmark (Head of Department), W. C. Ackermann, A. H-S. Ang, J. E. Baerwald, J. W. Briscoe, A. B. Chilton, V. T. Chow, E. Danner, D. U. Deere, R. S. Englebrecht, R. A. Eubanks, B. B. Ewing, S. J. Fenves, E. H. Gaylord, W. J. Hall, J. D. Haltiwanger (Associate Head of Department), W. W. Hay, M. Herrin, H. O. Ireland, H. M. Karara, C. E. Kesler, N. Khachaturian, T. E. Larson, J. L. Merritt, Jr., W. H. Munse, J. P. Murtha, R. E. Olson, J. E. Pearson, R. B. Peck, A. R. Robinson, M. O. Schmidt, L. R. Shaffer, C. P. Siess, G. K. Sinnamon, M. A. Sozen, J. E. Stallmeyer, T. H. Thornburn.

Associate Professors: J. H. Austin, E. J. Barenberg, C. L. Chen, M. T. Davisson, H. K. Hilsdorf, T. K. Liu, V. J. McDonald, J. W. Melin, R. J. Mosborg, N. N. Nielsen, J. T. O'Connor, J. T. Pfeffer, A. F. Richards, W. C. Schnobrich, R. N. Wright.

Assistant Professors: P. C. Birkemoe, D. M. Brown, E. J. Cording, R. I. Dick, W. L. Gamble, G. R. Gurfinkel, A. J. Hendron, Jr., E. R. Holley,

S. M. Holzer, J. W. Leonard, L. A. Lopez, C. R. Marek, W. H. C. Maxwell, B. Mohraz, E. L. Murphree, Jr., S. L. Paul, J. B. Radziminski, M. R. Thompson, C. C. Tung, W. H. Walker, H. G. Wenzel, Jr., K. W. Wong, B. C. Yen.

COURSES FOR GRADUATES

403. **Photogrammetry.** Study of the principles of stereoscopy and geometrical optics; aerial cameras, their design and calibration; the design, construction, and operation of stereoscopic plotting machines; mathematics of stereoscopic orientation and model deformations. 1 unit. Prerequisite: Civil Engineering 302 or consent of instructor. Karara.

404. **Photogrammetry.** Theory of errors of stereoscopic photogrammetry; aerotriangulation (spatial and radial), its theory and applications to various civil engineering problems; electronics in photogrammetry; practice in compiling maps from aerial and terrestrial photographs. 1 unit. Prerequisite: Civil Engineering 302 or consent of instructor. Karara.

405. **Analytical Aerotriangulation.** Iterative and simultaneous rigorous block adjustment methods, numerical methods for the solution of large systems of equations; characteristics of various analytical photogrammetric systems. 1 unit. Prerequisite: Civil Engineering 304 or consent of instructor.

416. **Design of Construction and Industrial Operations, I.** Same as Industrial Engineering 416. Conceptual development of a systems design procedure for optimal design of construction and industrial operations; general forms required for critical path networks, linear programs, theory of queues and inventory models required for systems design; design evaluation and control models. 1 unit. Prerequisite: Bachelor of Science in civil or industrial engineering; credit or registration in Mathematics 363; or consent of instructor. Shaffer.

417. **Design of Construction and Industrial Operations, II.** Same as Industrial Engineering 417. Continuation of Civil Engineering 416. 1 unit. Prerequisite: Civil Engineering or Industrial Engineering 416; credit or registration in Mathematics 315; or consent of instructor. Shaffer.

420. **Pavement Design, I.** Analysis and methods of measurement of surface properties related to vehicle performance; factors affecting pavement durability; traffic wear, climate, chemical action, combined effects; composition design of flexible and rigid pavements for proper surface properties, load carrying capacity, wear resistance, stability, and durability. 1 unit. Prerequisite: Civil Engineering 220 or equivalent. Danner.

421. **Pavement Design, II.** Structural design of flexible and rigid pavements; loading characteristics, static, impact and repeated loads; load distribution through pavement layers, factors affecting distribution, methods of analysis; evaluation of subgrade support; criteria for selecting design values. 1 unit. Prerequisite: Civil Engineering 220 or equivalent. Barenberg, Herrin.

422. **Fundamental Properties and Behavior of Bituminous Mixtures.** Composition and theories of physical structure of bitumens; rheological, failure, durability, and adhesive properties of bitumens and bituminous mixtures; analysis of factors influencing the performance of bituminous aggregate mixtures. 1 unit. Prerequisite: Civil Engineering 321 or consent of instructor. Herrin.

423. **Highway Materials Stabilization.** Stabilization of aggregates and soils with cement, lime, bituminous materials, and other stabilizing agents; basic stabilization reactions, properties of stabilized materials, and composition design are emphasized. 1 unit. Prerequisite: Civil Engineering 220 or consent of instructor. Thompson.

426. **Traffic Planning.** Traffic engineering planning functions; urban and rural master traffic plans; traffic analyses for new or existing streets, highways, and terminal facilities. 1 unit. Prerequisite: Civil Engineering 325 or equivalent. BAERWALD.

427. **Geometric Highway Design.** Highway classification; highway capacity; highway design controls; sight distance; horizontal and vertical alignment; cross section elements; highway types; controlled access highways; design of at-grade of intersections, grade separations, and interchanges. 1 unit. Prerequisite: Civil Engineering 325 and 426, or consent of instructor. BAERWALD.

428. **Traffic Engineering Operations.** Theory of traffic control; laws and ordinances; design and application of traffic control devices; special street designations; parking design and control; street illumination; miscellaneous traffic control designs. 1 unit. Prerequisite: Civil Engineering 325 and 426, or equivalent. BAERWALD.

435. **Railway Construction and Maintenance.** Roadbed load capacity; economic design of track; advanced geometric design; economics of maintenance; grade crossing separations; review of specific projects. 1 unit. Prerequisite: Civil Engineering 335. HAY.

436. **Railroad Location and Operation.** Track and traffic capacity; optimum train size, performance, and scheduling; validity and accuracy of current practices; regional operating factors; optimum size of plant and modern location. 1 unit. Prerequisite: Civil Engineering 336 or consent of instructor. HAY.

440. **Theory of Water Treatment.** Properties of water and criteria of water quality; gas transfer operations in water treatment; chemical treatment processes; corrosion and corrosion control; sedimentation; filtration; disinfection; control of aquatic growths; control of tastes and odors. 1 unit. Prerequisite: Chemistry 122 and Microbiology 101. DICK, O'CONNOR.

441. **Analysis and Treatment of Water and Waste Water.** Physical, biological, and chemical analysis of water and waste water; field sampling techniques; removal of objectionable impurities, principles of disinfection; determination of dissolved oxygen, biochemical oxygen demand, and chemical oxygen demand; nitrogen, sulfur, and phosphorous compounds in waste waters. 1 unit. Prerequisite: Credit or registration in Civil Engineering 440. AUSTIN, O'CONNOR.

442. **Theory of Waste-Water Treatment.** Composition, properties, and analysis of wastes; microbiology of waste treatment; pollution of natural waters; sedimentation; chemical treatment; aerobic and anaerobic treatment processes; disposal of waste sludges. 1 unit. Prerequisite; Civil Engineering 346; Chemistry 122; Microbiology 101. AUSTIN, ENGELBRECHT, PFEFFER.

443. **Advanced Sanitary Engineering Laboratory.** Experimental and pilot plant studies of the operational characteristics for various physical, chemical, and biological unit operations and processes used in the treatment of water and waste water. 1 unit. Prerequisite: Civil Engineering 441; credit or registration in Civil Engineering 442. DICK, O'CONNOR, PFEFFER.

444. **Industrial Water and Wastes Treatment.** The theory and application of unit operations unique to the treatment of industrial water and wastes; advanced consideration of industrial waste problems of major industries; techniques of saline water conversions. 1 unit. Prerequisite: Credit or registration in Civil Engineering 440 and 442, or consent of instructor. ENGELBRECHT, O'CONNOR.

445. **Water Quality and Pollution.** Water quality standards and criteria for various beneficial uses; transport mechanisms for pollution in surface streams and ground water; fate of pollution and pollution control. 1 unit. Prerequisite: Civil Engineering 250 and 251; Mathematics 345. DICK, EWING.

446. **Design of Water and Waste Treatment Plants.** A study of the fundamental

factors affecting choice of treatment units and combination of unit processes into an integrated plant. 1 unit. Prerequisite: Civil Engineering 440, credit or registration in Civil Engineering 442, or consent of instructor. DICK, PFEFFER.

447. Radioactive Waste Disposal. Same as Nuclear Engineering 447. Sources and characteristics of radioactive wastes; methods of treatment; ultimate disposal; fate of radioisotopes in the environment; permissible levels in air and water; current levels in water supplies; water treatment methods; monitoring techniques; solid waste disposal; gaseous wastes disposal; air-monitoring; and reactor site selection and hazards evaluation. ½ or 1 unit. Prerequisite: Physics 282, or Chemistry or Nuclear Engineering 398, or consent of instructor. AUSTIN, EWING.

448. Control of Air Pollution. A study of air contaminants from all types of sources; deleterious effects of contaminants on plants, animals, and materials; determination of source strength; basic theory of control devices; air pollution surveys; and organization of control programs. 1 unit. Prerequisite: General Engineering 360. AUSTIN, PEARSON.

449. Analysis of Air Pollutants. Laboratory analysis of common air pollutants; theory of operation of laboratory and automatic field instrumentation. ½ or 1 unit. Prerequisite: Credit or registration in Civil Engineering 448. AUSTIN, PEARSON.

450. Advanced Hydrologic Analysis and Design. Hydrologic cycle; hydrometeorology; collection of data; hyetograph and hydrograph analyses; infiltration and evapotranspiration studies; groundwater exploration and recharge; statistical analyses; determination of waterway areas; flood routing; river and reservoir regulations; design and planning of flood control projects; and modern development such as radar weather, radioactive tracers, disposal of nuclear wastes, and electronic analogs. 1 unit. Prerequisite: Bachelor of Science in civil engineering or consent of instructor. CHOW.

452. Water Resources. An advanced interdisciplinary course on water resources planning and development; geographic aspects; data collection; governmental functions; hydrologic implications; river hydraulics; hydraulic physical units and water quality; economic aspects; legal, political, and social problems; case studies. 1 unit. Prerequisite: Consent of instructor. CHOW, STAFF.

457. Ground Water. An advanced interdisciplinary course on ground water; hydrogeology; hydrodynamics of flow through porous media; ground water hydrology; hydraulics of wells; hydraulic analysis of seepage; ground water pollution; ground water resources. 1 unit. Prerequisite: Consent of instructor. STAFF.

458. Open-Channel Hydraulics. Basic hydromechanics; flow types; channel characteristics; flow-profile computations; hydraulic jump analysis; design of nonerodible, erodible, and grassed channels and transitional structures; study of supercritical flow and unsteady flow; modern developments in theory and design practice; application of numerical method, method of characteristics, method of singular point, and electronic digital computers and analogs. 1 unit. Prerequisite: Bachelor of Science in civil engineering or consent of instructor. CHOW, WENZEL.

461. Structural Theory and Design. Advanced structural theory from the standpoint of design, analysis, and behavior, with particular emphasis on analysis; evaluation of methods of elastic analysis of structures; limit design and analysis; continuous beams and frames; multiple-story structures; space frames; arches. 1 unit. Prerequisite: Bachelor of Science in civil engineering; Civil Engineering 361 or 460, or equivalent. FENVES, HALL, STALLMEYER.

463. Optimization of Structures. Structural design processes; formulation of problems in the optimization of structures; optimization of structural elements; minimum volume principles; use of mathematical programming in optimization of structural systems. 1 unit. Prerequisite: Consent of instructor. KHACHATURIAN.

465. Structural Design in Metals. Theories of behavior of structural metal members and their components; interpretation of codes and specifications for the design of bridges and buildings. This course and Civil Engineering 475 form a unit in the study of theoretical and experimental investigations. 1 unit. Prerequisite: Bachelor of Science in engineering with courses in structures. GAYLORD.

467. Behavior of Reinforced Concrete Structures. Utlimate strength and behavior of statically indeterminate reinforced concrete structures; applicability of elastic analysis to framed structures; analysis and design of floor slabs in buildings. 1 unit. Prerequisite: Civil Engineering 366. SIESS.

469. Thin Shell Structures. Fundamental membrane and bending theories of shells; application of theories to analysis and design of folded plates and cylindrical, rotational, and translational shells; membrane stresses and deflections; and approximate bending solutions by variational, finite-difference, and finite-element methods. 1 unit. Prerequisite: Civil Engineering 473 or consent of instructor. SCHNOBRICH.

470. Statistical Theory of Structural Engineering. Study of the concepts and applications of probability and statistical theory in structural engineering and research, with emphasis on the scientific principles for considering fluctuations and randomness in physical phenomena and processes; mathematical modeling in structural mechanics including Monte Carlo simulation in structural systems analysis and design; engineering decision-making under uncertainty; analysis of loads and resistances; safety analysis of structures including system reliability prediction; introduction to stochastic structural dynamics. 1 unit. Prerequisite: Consent of instructor. ANG.

471. Numerical and Approximate Methods of Structural Analysis. Methods of successive approximations and numerical procedures for the solution of complex problems with applications to bridges, buildings, and aircraft structures: influence lines, moments and deflections of beams with axial load, buckling strength of columns, moments and deflections of beams resting on elastic or plastic supports, vibration of beams, analysis of arches, moments, and deflections of plates; other problems. 1 to 2 units. EUBANKS, ROBINSON.

472. Advanced Numerical Methods in Engineering. Basic concepts in numerical and approximate methods: successive approximations, relaxation, finite differences, ordinary boundary value problems, initial value problems, partial differential equations, characteristic value problems, methods of interpolation, variational procedures. Special study of selected topics including vibrations of complex structures; blast, impact, and earthquake effects on structures; buckling and flexure of frameworks; torsion of solid and thin-walled sections; lateral buckling of beams; bending and buckling of plates and of stiffened plates; plane stress and axially symmetric problems in elasticity; other topics. 1 to 2 units. Prerequisite: Civil Engineering 471. ROBINSON.

473. Analysis and Design of Plates and Shells. Fundamental theories of bending and buckling of plates; practical application of theories in analysis and design of reinforced concrete bridge and building floors, highways and airport pavements, and structural plate components in metal; theory of shells with application to tanks, pressure vessels, shell roofs, and hipped plate construction. 1 to 2 units. Prerequisite: Consent of instructor. SCHNOBRICH.

474. Behavior of Structures Under Dynamic Loads. Free vibrations, forced vibration, and transient response of structures and structural components having one or many degrees of freedom; analytical methods for the effects of wind load, explosion blast, impact, earth tremors, and other time-dependent excitations; effects of damping and inelastic action; propagation of stress waves; wind-induced vibrations with application to cables, pipelines, and tall stacks. 1 to 2 units. Prerequisite: Consent of instructor. WALKER.

475. Behavior of Steel Structures. A critical evaluation of the actual behavior of metals, connections, members, and structures; the significance of this behavior in terms of design and the development of design specifications. This course and Civil Engineering 465 form a unit in the study of theoretical and experimental investigations. 1 unit. Prerequisite: Graduate standing in civil engineering or theoretical and applied mechanics. MUNSE.

476. Plastic Analysis and Design. Inelastic behavior of metal structural frameworks; concept of the plastic hinge; collapse configurations; analysis of collapse mechanisms; requirements for stability; deflections, incremental collapse, shakedown; connections; optimum design; grid frameworks. 1 unit. Prerequisite: Civil Engineering 465 or consent of instructor. GAYLORD.

477. Design of Structures for Dynamic Loads. Nature of dynamic loading from earthquakes and bomb blasts; nature of dynamic resistance of structural elements and complete structures; concepts of limit design; review of methods of analysis; significance and interpretation of results of analyses; criteria for design of blast-resistant structures; criteria for design of earthquake-resistant structures; application to actual problems. 1 unit. Prerequisite: Consent of instructor. HALTIWANGER.

480. Earth Pressures and Retaining Structures. Classical and modern earth pressure theories and their experimental justification; pressures and bases for design of retaining walls, bracing of open cuts, anchored bulkheads, cofferdams, tunnels, and culverts. 1 unit. Prerequisite: Credit or registration in Civil Engineering 384. IRELAND, PECK.

481. Earth Dams and Related Problems. Fundamentals of problems of slope stability; seepage in composite sections and anisotropic materials; methods of stability analysis; mechanism of failure of natural and artificial slopes; compaction; field observations. 1 unit. Prerequisite: Credit or registration in Civil Engineering 384, or consent of instructor. PECK.

482. Advanced Soil Mechanics, I. Theoretical and experimental studies in soil mechanics, stress distribution in homogeneous and stratified soils, theory of consolidation for multidirectional flow and time dependent loading, numerical methods, secondary consolidation, settlement analysis, experimental measurements. 1 unit. Prerequisite: Civil Engineering 383. OLSON.

483. Advanced Soil Mechanics, II. Theoretical and experimental studies in soil mechanics, shearing properties of saturated soils, physical properties of partially saturated soils, physicochemical properties of clays, laboratory direct shear and triaxial shear testing. 1 unit. Prerequisite: Civil Engineering 383. OLSON.

484. Foundation Engineering. Critical study of case histories of projects in foundation engineering; current procedure for design and construction of foundations, embankments, and waterfront structures. 1 unit. Prerequisite: Civil Engineering 384. IRELAND, PECK.

485. Soil Engineering for Transportation Facilities. Problems of soil classification; evaluation of stability of natural and compacted soils as subgrades, slopes, and embankments; effect of climate, soil properties, compaction, and admixtures on subgrade stability. 1 unit. Prerequisite: Civil Engineering 383 or equivalent. LIU, THORNBURN.

494. Municipal Administration and Engineering. Legal authority of municipalities, forms of municipal government; municipal functions, organization, and management; city finance; engineering functions of city government; city planning and zoning; building codes and inspection; street lighting; public utilities; city cleaning; recreational development. 1 unit. Prerequisite: Bachelor of Science in civil engineering or consent of instructor. DANNER.

495. Civil and Sanitary Engineering Seminar. Discussion of current topics in civil and sanitary engineering and related fields by staff, students, and visiting lecturers. Course may be repeated. 0 or ¼ unit.

497. Special Problems. Individual investigations or studies of any phase of civil engineering selected by the student and approved by his adviser and the staff member who will supervise the investigation. 0 to 4 units. Prerequisite: Consent of instructor.

499. Thesis Research. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Advanced Surveying. Precise horizontal and vertical control surveys; state plane coordinate systems; special construction surveys. ½ unit. Prerequisite: Civil Engineering 202 or consent of instructor.

304. Fundamentals of Analytical Photogrammetry. An introduction to the basic principles, procedures, and methods of analytical photogrammetry, including relative and absolute orientation, and strip and block adjustment. ¾ or 1 unit. Prerequisite: Civil Engineering 203 and 306 or consent of instructor.

305. Observational Astronomy. Same as Astronomy 314. Astronomical coordinate systems and transformations; theory of, and practice in, approximate and precise determinations of latitude, longitude, and time; introduction to theory of errors; theory and practice of astronomical photography. 1 unit. Prerequisite: Astronomy 102 or 210, or Civil Engineering 201; Mathematics 142 or 143.

306. Adjustment of Observations. A study of the methods of least squares and its application to the adjustment of photogrammetric and geodetic problems; formation and solution of the normal equations, including the use of matrix algebra; types of adjustments including adjustments for hybrid systems; discussion of the normal distribution and the statistical foundations of the method of least squares. ¾ or 1 unit. Prerequisite: Mathematics 315 and Civil Engineering 202, or consent of instructor.

307. Photogrammetric Engineering. A study of metrical photography in civil engineering practice, analytical and analogue photogrammetric systems, photometrics and outer space mapping techniques, and automated photographic mapping systems. ¾ or 1 unit. Prerequisite: Civil Engineering 203 or consent of instructor.

314. Fundamentals of Systems Approach. Introduction to the application of linear programming, network theory, and queueing theory to the synthesis of civil engineering systems. ½ or 1 unit. Prerequisite: Civil Engineering 215; Mathematics 263 or consent of instructor.

315. Construction Productivity. Introduction to the application of scientific principles to the measurement of and the forecasting of productivity in construction engineering; conceptual and mathematical formulations of the labor, equipment, and material factors affecting productivity. ½ or 1 unit. Prerequisite: Civil Engineering 215; credit or registration in Mathematics 263 or equivalent; or consent of instructor.

316. Construction Planning. Introduction to the application of scientific principles to the normative planning of construction operations. ½ or 1 unit. Prerequisite: Civil Engineering 315 or consent of instructor.

318. Construction Cost Analyses and Estimates. Introduction to the application of scientific principles to costs and estimates of costs in construction engineering; concepts of and statistical measurements of the factors involved in direct costs, general overhead costs, cost mark-ups and profits; the fundamentals of cost

recording for construction cost accounts and cost controls. ½ or 1 unit. Prerequisite: Civil Engineering 315 or consent of instructor.

321. **Bituminous Materials and Mix Design.** Properties and control testing of bituminous materials; analysis of bituminous paving mixtures; composition and design of asphaltic concrete and soil-asphalt mixes. ½ unit. Prerequisite: Civil Engineering 214 and 220, or consent of instructor.

322. **Development of Highway Facilities.** Analysis of factors in developing a highway transportation facility; traffic estimates and assignment; problems of highway geometrics and design standards; planning and location principles; intersection design factors; street systems and terminal facilities; programming improvements; drainage design; structural design of surface; concepts of highway management and finance; highway maintenance planning. 1 unit. Prequisite: Civil Engineering 220 or consent of instructor.

325. **Highway Traffic Characteristics.** Vehicle operating characteristics; driver characteristics; pedestrian characteristics; roadway characteristics as they individually and collectively as traffic stream characteristics are related to the planning, design, and operation of highway facilities. ½ unit. Prerequisite: Civil Engineering 220 or consent of instructor.

333. **Urban and Regional Transportation.** Importance of transportation and its relation to urban and regional planning; characteristics of transport systems: transportation planning including surveys, data analysis, and problems of administration and finance; coordination and integration of transport. ½ or 1 unit. Prerequisite: Consent of instructor.

334. **Airport Design.** Basic principles of site selection for airports and fundamental considerations of design, construction, and maintenance of airport pavements and structures. ½ or 1 unit. Prerequisite: Civil Engineering 220 and senior standing in civil engineering, or consent of instructor.

335. **Railway Construction and Maintenance.** Loads and load distribution on track and subgrade; roadbed construction and stabilization; track stresses, design, and materials; turnouts and crossings; maintenance programs. ½ or 1 unit. Prerequisite: Consent of instructor; credit or registration in Civil Engineering 230 for those with a minor in railroad or transportation engineering.

336. **Railway Location and Operation.** Influence of traffic, alignment, distance, gradients, and motive power upon operating expenses; mechanics of train operation; economic design of location. ½ or 1 unit. Prerequisite: Consent of instructor; credit or registration in Civil Engineering 230 for those with a minor in railroad or transportation engineering.

337. **Signals.** Train movements; systems of signals; track circuits; track capacity; interlockings; economics of signaling. ½ or 1 unit. Prerequisite: Consent of instructor; credit or registration in Civil Engineering 230 for those with a minor in railroad or transportation engineering.

338. **Terminals.** Design and operation of freight terminal facilities for rail, highway, air, and water carriers; passenger terminals; special terminal requirements for specific commodity categories; coordination. ½ or 1 unit. Prerequisite: Consent of instructor; credit or registration in Civil Engineering 230 for those with a minor in railroad or transportation engineering.

345. **Environmental Health Engineering.** The application of engineering principles to the control of environmental sanitation and communicable disease control, including adminstration, biostatistics, epidemiology, vector control, pesticides, milk and food sanitation, swimming pools, individual water supply and wastewater disposal, plumbing, refuse collection and disposal, industrial hygiene and

air pollution, radiological health and international health. ¾ unit. Prerequisite: Consent of instructor.

346. **Biology of Polluted Water.** The significance of biology in water quality, stream pollution, and waste treatment. ½ unit. Prerequisite: Consent of instructor.

349. **Fundamentals of Radiation Protection.** Same as Nuclear Engineering 349. Principles and practice of health physics and radiation protection engineering, including such topics as: principles of dosimetry; sources of ionizing radiation; determination of radiation tolerances; dosimetric instruments; standards and regulations. ¾ or 1 unit. Prerequisite: Credit or registration in Nuclear Engineering 397 or Physics 382, or equivalent.

351. **Hydromechanics.** Applied fluid mechanics with particular reference to topics in hydraulic design, analysis, and research in civil engineering areas; covers dimensional analysis and dynamic similarity, analysis of potential flow, boundary-layer problems, turbulence, and diffusion; hydraulic transients, water waves, transport phenomena. ¾ unit. Prerequisite: Theoretical and Applied Mechanics 235; Civil Engineering 251.

352. **Water Resources Design.** Study and evaluation of phases of river mechanics; water resources history and project implementation; development of a water resources project plan. ¾ unit. Prerequisite: Civil Engineering 250; Theoretical and Applied Mechanics 235.

353. **Hydraulic Structures.** Introduction to the design of hydraulic structures, including consideration of types and function of dams; hydrologic design; hydraulic design of spillways and outlet works; determination of loads and stresses for concrete structures; seepage, piping, and stability of earth structures. ¾ unit. Prerequisite: Civil Engineering 250 and 251.

354. **Hydraulic Engineering Laboratory.** Fundamental principles, operation, and use of model laboratories; dimensional analysis; hydraulic similitude; theory and design of hydraulic models as applied to a specific laboratory problem. ¾ unit. Prerequisite: Theoretical and Applied Mechanics 235.

356. **Hydraulics of Surface Drainage.** Applications of hydraulics and hydrologic principles; elements of channel design, hydrologic determination of design flow; flow through bridge openings and other obstacles; hydraulics of drainage areas; overland flow; runoff from highways; runways and urbanized areas; hydraulics of storm-drain systems; culvert design. ¾ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 235; Civil Engineering 250 or consent of instructor.

361. **Advanced Structural Analysis.** Numerical methods of structural analysis; general theory of continuity; prismatic and nonprismatic members; continuous framed structures; trussed structures; lateral load distribution; secondary stresses. ¾ or 1 unit. Prerequisite: Civil Engineering 262 or equivalent.

363. **Behavior and Design of Metal Structures, II.** Members under combined loads; welded, riveted, and bolted connections; moment-resistance connections; plastic design. ¾ or 1 unit. Prerequisite: Civil Engineering 263 or consent of instructor.

364. **Reinforced Concrete Design, II.** Limit design of continuous reinforced concrete members and slabs of various types. ¾ or 1 unit. Prerequisite: Civil Engineering 264; credit or registration in Civil Engineering 262.

366. **Behavior of Reinforced Concrete Members.** Ultimate strength and behavior of reinforced concrete members and relation between results of research and current specifications for design; members subjected to flexure, axial compression, combined flexure and axial load, combined flexure and shear, and bond. 1 unit. Prerequisite: Bachelor of Science in civil engineering or architecture with courses in structures and reinforced concrete design.

368. **Prestressed Concrete.** Principles and methods of linear prestressing; behavior, strength, and design of noncomposite simple beams, composite simple beams, and continuous beams; time-dependent variables and long-time deflections. ¼ or 1 unit. Prerequisite: Civil Engineering 262 and 264.

369. **Behavior and Design of Wood Structures.** Theory and practice in design of modern wood structures; effect of plant origin and physical structure of wood on its mechanical strength; fasteners and their significance in design and the development of design formulae. ¾ or 1 unit. Prerequisite: Civil Engineering 261 or equivalent, or consent of instructor.

379. **Applied Structural Mechanics.** Study of beams under lateral load; beams with combined lateral load and thrust; buckling; beams on elastic foundations; applications of Fourier series and virtual work principles to beam-type structures; stress and strain in three dimensions; applications to flexure of beams and plates and to constrained torsion; elements of the engineering theory of plates. 1 unit. Prerequisite: Mathematics 345 and one undergraduate course in statically indeterminate structures, or consent of instructor.

383. **Soil Mechanics.** Identification, description, and classification of soils; index properties, weight-volume relationships; hydraulic properties; stress-deformation characteristics; utlimate strength; subsurface exploration; character of natural soil deposits. ¾ or 1 unit. Prerequisite: Consent of instructor.

384. **Applied Soil Mechanics.** Application of soil mechanics to foundations of buildings; stability of earth slopes; earth pressure and retaining walls; braced cuts; damage due to construction operations. ¾ or 1 unit. Prerequisite: Civil Engineering 383 or consent of instructor.

385. **Engineering Aspects of Surficial Soils.** Use of geologic and pedologic information and airphoto interpretation techniques in the prediction of engineering properties of soils and the planning of engineering soil surveys. Field trip: estimated expense, $5.00. 1 unit. Prerequisite: Civil Engineering 210 or consent of instructor.

391. **Computer Methods in Civil Engineering.** Review of programming concepts; formulation and programming of numerical, data-processing, and logical problems with applications to various branches of civil engineering; organization of programs and data; development and use of problem-oriented programming languages in civil engineering. ½ or 1 unit. Additional work required for more than ½ unit of credit. Prerequisite: Computer Science 101 or equivalent; senior or graduate standing in the Department of Civil Engineering or consent of instructor.

THE CLASSICS

(Including Classical Civilization, Greek, and Latin)

The Department of Classics offers graduate work leading to the Master of Arts and Doctor of Philosophy.

The Master of Arts may be taken in Latin, in Greek, in the Classics, or in the Teaching of Latin. For the Master of Arts in the Classics, the major may be either Latin or Greek, with the other language offered as a minor. No master's thesis is required; extra units of work in Greek or Latin are substituted for the thesis.

The Doctor of Philosophy is given in Classical Philology. Major work may be taken in either Latin or Greek, but whichever language is taken as a major, the other one must be taken either as the sole minor or as a first minor.

The minimum grade-point average for admission to graduate study in the department is 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis. All graduate students should take Greek or Latin 495-496, Bibliography and Criticism, during their first year of graduate

study. Other regulations of the department governing graduate studies are described in a departmental brochure which may be obtained by writing to the head of the department, 361 Lincoln Hall.

At the beginning of each term, written examinations in the translation of Greek and Latin are scheduled. Candidates for the master's degree (or equivalent) must take one examination in their major language each term. Advanced students must take both the Greek and Latin examinations each term until they have been exempted from the requirement or the preliminary examination has been passed. Satisfactory performance in both languages is required before admission to the preliminary examination.

GRADUATE FACULTY

Professors: J. L. Heller, R. P. Oliver, A. Turyn, L. Wallach.

Associate Professors: J. J. Bateman (Head of Department), M. Naoumides, R. T. Scanlan, R. E. Wolverton.

Assistant Professor: M. R. Dilts.

Classical Civilization

The following courses presuppose no knowledge of the Greek or Latin language and are open to all students. For other courses in the area of classical civilization, see Art 304, 305, 306, 307, and 454; History 381, 382, 383, 384, 411, and 413; Philosophy 303, 309, 310, and 401; and Speech 411 and 412.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Greek Literature in Translation. An introduction to Greek literature from Homer to the Hellenistic age and to its cultural and historical background. ½ unit. Prerequisite: Consent of instructor. Naoumides.

302. Latin Literature in Translation. An introduction to Latin literature of the classical period and to its cultural and historical background. ½ unit. Prerequisite: Consent of instructor. Naoumides.

361. The Archaeology of Greece. Monuments and material remains illustrating the development of Greek civilization to 323 B.C. ½ unit. Prerequisite: A course in ancient history, art, or language, or consent of instructor. Allen.

362. The Archaeology of Italy. Monuments and material remains illustrating the development of Graeco-Roman and other ancient Italian civilizations to 303 A.D. ½ unit. Prerequisite: A course in ancient history, art, or language, or consent of instructor. Allen.

Greek

Preparation for first-year graduate work in Greek should include at least three years of college Greek, or equivalent, and two years of college Latin. A reading knowledge of German and French is important for candidates in this subject. The study of history and philosophy is especially recommended.

COURSES FOR GRADUATES

In any given semester, a selection from the following courses is offered. Consult the departmental office, 361 Lincoln Hall, well in advance of registration.

Unless otherwise noted, the prerequisite to all courses is three years of college Greek.

409. Greek Versification. Greek prosody; survey of meters, lines, and cola in epic, lyric, and dramatic poetry; lyric meters of Greek drama. 1 unit. TURYN.

411. Hellenistic Literature. 1 unit. BATEMAN.

412. Lucian and His Age. 1 unit.

413. Greek Lyric Poetry. 1 unit. TURYN.

414. Pindar. 1 unit. NAOUMIDES.

415. Homer. 1 unit. BATEMAN.

416. Thucydides. 1 unit. NAOUMIDES.

417. Bacchylides. 1 unit. NAOUMIDES.

422. Sophocles. 1 unit. TURYN.

423. Aeschylus. 1 unit. TURYN.

424. Euripides. 1 unit. TURYN.

425. Greek Drama: Comedy. 1 unit. TURYN.

491. Directed Reading. ¼ to 1 unit; no student may offer more than 1 unit of credit in this course toward the Ph.D. degree. Prerequisite: Second-year graduate standing.

495. Bibliography and Criticism. Same as Latin 495. Introduction to the methods and techniques of scholarship. ½ unit. OLIVER.

496. Bibliography and Criticism. Same as Latin 496. ½ unit. OLIVER.

499. Thesis Research. Guidance in writing theses for advanced degrees. 0 to 4 units. BATEMAN, HELLER, NAOUMIDES, OLIVER, TURYN.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Third-Year Greek. Readings in Attic prose. ½ unit. Prerequisite: Greek 202.

302. Third-Year Greek. Continuation of Greek 301. Readings in Greek Tragedy. ½ unit. Prerequisite: Greek 301.

308. Comparative Grammar of Greek and Latin. Same as Latin and Linguistics 308. A historical study of the Greek and Latin languages through use of the comparative method. ½ unit. Prerequisite: Latin 202 or equivalent; credit or registration in Greek 202. HELLER.

391. Readings in Greek Literature. Readings from Greek authors chosen by the instructor chiefly from the following list of authors and topics (others may be chosen): Herodotus, Tragedy, Comedy, Lyric Poetry, Aristotle, Oratory, New Testament, Survey of Greek Literature. ¾ unit. Prerequisite: Greek 302 or equivalent.

Latin

Preparation for first-year graduate work in Latin should include at least two years of preparatory Latin and three years of college Latin. A reading knowledge of French and German is important. Some acquaintance with Greek is highly desirable, and the study of history and philosophy is especially recommended.

Candidates for the Master of Arts in the Teaching of Latin must earn four units in Latin, two units in education, and two units in electives. Three of the four required

units in Latin must be in courses numbered above 400; the other unit is from Latin 311, 312, or 391. The required work in education consists of Educational Psychology 311 and 312 and one unit selected from History and Philosophy of Education 303, 304, 305. The electives may be in Latin, in Greek, in education, or, in exceptional cases, in other fields. The courses in Latin and the electives must be selected with the approval of the adviser, Professor J. J. Bateman, 361 Lincoln Hall. See pages 45 and 46.

COURSES FOR GRADUATES

In any given semester, a selection from the following courses is offered. Consult the departmental office, 361 Lincoln Hall, well in advance of registration.

Unless otherwise noted, the prerequisite to all courses is three years of college Latin or equivalent.

401. Readings in Latin for Graduate Students. Directed readings, largely in medieval and modern Latin. Designed for graduate students who need to use Latin in their research. No graduate credit. Prerequisite: Two years of high school Latin or equivalent.

409. History of the Latin Language. 1 unit. Prerequisite: Two years of college Latin or equivalent; two years of a modern foreign language.

410. Vulgar Latin. 1 unit. Prerequisite: Two years of college Latin; two years of a Romance language.

411. Latin Epigraphy. 1 unit. Prerequisite: Three years of college Latin or equivalent; one year of ancient history. OLIVER.

412. Latin Elegy. 1 unit. OLIVER.

413. Caesar. 1 unit. TURYN.

414. Lucan. 1 unit. OLIVER.

415. Lucretius. 1 unit.

416. Vergil. 1 unit. BATEMAN.

421. Horace. 1 unit. BATEMAN.

422. Plautus and Terence. 1 unit. TURYN.

423. Latin Romance. 1 unit.

425. Cicero. 1 unit. TURYN.

426. Tacitus. The *Annales*. 1 unit. OLIVER.

427. Roman Satire. 1 unit. HELLER.

441. Latin Paleography. 1 unit. WALLACH.

491. Directed Reading. ¼ to 1 unit; no student may offer more than 1 unit of credit in this course toward the Ph.D. degree. Prerequisite: Second-year graduate standing.

495. Bibliography and Criticism. Same as Greek 495. Introduction to the methods and techniques of scholarship. ½ unit. OLIVER.

496. Bibliography and Criticism. Same as Greek 496. ½ unit. OLIVER.

499. Thesis Research. Guidance in writing theses for advanced degrees. 0 to 4 units. BATEMAN, HELLER, NAOUMIDES, OLIVER, WALLACH.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. Comparative Grammar of Greek and Latin. Same as Greek and Linguistics 308. A historical study of the Greek and Latin languages through use of the compara-

tive method. ½ unit. Prerequisite: Latin 202 or equivalent; credit or registration in Greek 202. HELLER.

311. Advanced Latin Composition. Practice in the writing of Latin prose. ½ unit. Prerequisite: Twelve hours of Latin acceptable for a major. OLIVER.

312. Advanced Latin Composition. ½ unit. Prerequisite: Latin 311. OLIVER.

313. Oral Latin. Introduction to the use of Latin as a means of oral communication, with particular reference to instruction in secondary schools. S; ½ unit. Prerequisite: Latin 312 or consent of instructor.

391. Readings in Latin Literature. Readings from Latin authors chosen by the instructor chiefly from the following list of authors and topics (others may be chosen): Livy, Horace, Vergil, Cicero's *Orations*, Seneca, Ovid, Cicero's *Essays*, Patristic Latin, Medieval Latin. ¼ unit. Prerequisite: Three years of college Latin or equivalent; consent of instructor. STAFF.

COMMUNICATIONS

Doctor of Philosophy in Communications. This program is administered by an interdepartmental committee in the College of Communications. It provides a core program in communications and permits advanced specialization in several areas: process, content, and effects of the mass media, including their political, social, and economic aspects; advertising; interpersonal communication; psycholinguistics.

The program applies the methods and disciplines of the social sciences, supported by the humanities, fine and applied arts, and natural sciences, to the basic problems of human communications. It is intended for students who plan careers in teaching communication subjects such as journalism, radio-television, and psycholinguistics; scholarly research on the development, control, and ethics of the mass media; experimental research on public opinion measurement; advertising, communication effects, psycholinguistics, and semantics; executive jobs in government and industry requiring breadth, perspective, and a scholarly background.

Prerequisite to admission is a 4.0 grade average and a broad background in the social sciences and humanities. Many of the advanced courses have introductory courses as prerequisites. An introductory course in statistics is generally useful.

The program provides both an introduction to the broad field of communications with its related disciplines (requirements 1, 2, and 4, below), and specialization in a subfield (requirements 3 and 5). The student must meet these detailed requirements:

(1) Communications 471 and 472, Proseminar, two units.

(2) One unit selected from Group A (Communications 414, 432, 444, 462, 468, 470, 473, 474, 481, 483, 307, 308, 344, 360), and one unit from Group B (Communications 420, 424, 425, 426, 436, 456, 325, 351, 352, 370).

(3) An area of specialization in communications. The following are suggested areas: theory of communications, philosophy of communications, communications policies and structures, public opinion and attitude formation, advertising (illustrated by Group A above); interpersonal communication, psycholinguistics (illustrated by Group B (above). Occasionally the Committee will approve other specializations. Two units must be taken in courses in research methods; such courses may deal with the philosophical, historical, mathematical, or technical aspects of inquiry and research. Courses for the area of specialization are not limited to courses cross-listed with communications. With his adviser's approval, a student may offer any relevant graduate course as part of the major.

(4) Either a sole minor of four units in a discipline other than communications, or a split minor with three units in a discipline other than communications and three units in a field of communications outside the area of concentration. (If the concentration is in Group A, the minor must be in Group B, and *vice versa*.) Courses cross-listed

in communications may not be counted toward a minor in a discipline other than communications.

(5) Communications 499, Thesis Research, eight units.

(6) Language requirements of the Graduate College.

(7) A preliminary written and oral examination.

(8) A final oral examination centered on but not restricted to the field of the dissertation.

Minor. A doctoral candidate wishing to minor in communications should select four, three, or two units (according to the requirements of his major department). Communications 471 and 472 are recommended as giving a broad survey of theory and research in this area. Candidates minoring in communications are expected to have a social science background for the courses they choose.

Further information may be obtained from the chairman of the administrative committee, Professor Theodore Peterson, 119d Gregory Hall.

GRADUATE FACULTY

Professors: T. Peterson (Chairman of Committee on Graduate Study in Communications), J. B. Casagrande, C. B. Hagan, J. E. Hulett, J. W. Jensen, H. L. Mueller, C. E. Osgood, H. J. Skornia.

Associate Professors: J. W. Carey, M. E. Fishbein, H. S. Maclay, Rita J. Simon.

Assistant Professors: R. N. Faber, Nancy Wiggins.

COURSES FOR GRADUATES

414. Seminar on Social Interaction. Same as Sociology 414. An analysis of social interaction based on the social psychology of C. H. Cooley, G. H. Mead, and W. I. Thomas. Problems of theory, concepts, and method. 1 unit. Prerequisite: One unit of graduate credit in sociology. Hulett.

420. Seminar in Semantics. Same as Philosophy 420. Intensive study of important contemporary contributions in the fields of semantics, analytic philosophy, and the philosophy of language. ¾ or 1 unit. Faber.

424. Linguistics and Communication. Same as Linguistics 424. The communicative function of language with emphasis on the application of linguistic theories and methods to problems in human communication. 1 unit. Maclay.

425. Psycholinguistics. Same as Linguistics and Psychology 425. A critical survey of methods and theories in the psychological study of the communication process with emphasis upon linguistic, information-theory, and learning-theory approaches, psycholinguistic analysis of language decoding and encoding, and the development and measurement of symbolic processes, including meaning. 1 unit. Prerequisite: Consent of instructor. Osgood.

426. Research Seminar in Psycholinguistics. Same as Linguistics and Psychology 426. Critical discussion of research problems to which psycholinguistic theories and techniques can be applied. Students taking this course plan, execute, and report an original piece of research in this area. ½ or 1 unit. Prerequisite: Communications 425; consent of instructor. Osgood.

432. Books and Libraries Since the Renaissance. Same as Library Science 432. The development of printing since the fifteenth century and its effect on the nature and use of the book; the growth of national, college and university, public, and other libraries in Europe and America from the Renaissance to the present day. 1 unit. Stevens.

436. Problems of Cybernetics. Same as Biophysics 436 and Electrical Engineering 474. The study of brain-like processes in complex dynamic systems with emphasis

on unsolved problems, current developments, and opportunities for research. 1 unit. Prerequisite: Consent of instructor. ASHBY.

444. Seminar in Public Opinion. Same as Sociology 444. Development and theory of public opinion process in society; censorship, interest groups, and propaganda; mass media and public opinion. 1 unit. SIMON.

456. Psychology of Social Communication. Same as Psychology 456. Recent developments in method and theory of attitude change through communication; the nature and determinants of informal social communication; the effects of persuasive communications on public opinion; change in intergroup attitudes through communication. 1 unit. Prerequisite: Psychology 351 or equivalent, or consent of instructor. FISHBEIN.

462. Seminar in Radio and Television. Same as Radio-Television 462. A study of the performance of radio and television in terms of content, government and industry controls, social responsibility, economic bases, and psychological and social effects. 1 unit. SKORNIA.

463. World Broadcasting. Same as Radio-Television 463. A study of the broadcast systems used by the nations of the world; alternative and "mixed" systems; international organizations, agreements, exchanges, and problems; broadcasts to and from other countries; implications of such new developments as satellites; mass and non-mass uses. 1 unit. Prerequisite: Radio-Television 462 or consent of instructor. SKORNIA.

468. The Political Economy of Communications. Same as Journalism 468. Analysis of the structure, policy, and behavior of such media of communications as newspapers, magazines, books, postal service, telegraph, telephone, broadcasting, and film, with special emphasis on their relationships to political order and the economy. 1 unit. GUBACK.

470. Communications and Popular Culture. Same as Journalism 470. Problems of cultural analysis related to the media of communications; social implications of communications research. 1 unit.

471. Proseminar in Communications, I. Same as Journalism 471. A general discussion of the mass media of communications, their role as social institutions, their control and support; content, audience, and effect of the mass media. 1 unit. CAREY, STAFF.

472. Proseminar in Communications, II. Same as Journalism 472. A general discussion of the problem of communications, including the individual as a communicating system, symbolic processes, analysis of messages, psycholinguistics, and language as social behavior. 1 unit. MACLAY, STAFF.

473. History and Theory of Freedom of the Press. Same as Journalism 473. Development of the Anglo-American press system and the idea of freedom of the press; contemporary mass media and their implications for freedom and democracy. 1 unit. JENSEN.

474. Communications Systems. Same as Journalism 474. Analysis of the structure and development of communications systems; examination of the role of communication in social change, political movements, and formal organizations. 1 unit. CAREY.

481. Advanced Advertising Principles. Same as Advertising 481. Emphasis is placed on determination and understanding of the principles as related to the science, philosophy, and art of advertising. Students may not receive graduate credit for both Communications 481 and Advertising 388. 1 unit. WEDDING.

482. Research Methods in Advertising and Communications. Same as Advertising 482. A treatment of basic research concepts and procedures in the social sciences

with emphasis on advertising and communications. Both nonquantitative and quantitative methods are examined. 1 unit. DUNN.

483. **Advertising and the Mass Media.** Same as Advertising 483. Functions of mass media as carriers of advertising messages; quantitative and qualitative audience research and analysis; formulation of media plans to achieve specific communications objectives. 1 unit.

490. **Special Topics in Communications.** ½ to 2 units. Prerequisite: Consent of chairman of Committee on Graduate Study in Communications. STAFF.

492. **Research Methods in Communications.** Same as Journalism 492. An introduction to the methods of empirical research in the behavioral sciences applicable to research problems in human communication, with emphasis on studies of mass communication. Lectures, readings, and laboratory practice. 1 unit. Prerequisite: An introductory statistics course or consent of instructor. WIGGINS.

499. **Thesis Research.** 0 to 4 units. Students may reregister for a total of eight units. Prerequisite: Consent of chairman of Committee on Graduate Study in Communications and of thesis supervisor. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

307. **The Art of the Screen: Narration.** Same as Speech 307. Critical study of the adaptation and synthesis of principles of drama, literature, the graphic arts, and music in the evolution of the screen narrative. Lectures, discussions, and reports; viewing of selected films and television programs. ½ unit. Prerequisite: Training in critical approaches to literature, drama, art, or music; consent of instructor. MUELLER.

308. **The Art of the Screen: Exposition and Persuasion.** Same as Speech 308. Critical study of the application of the eclectic principles of the screen narrative to the transmission of information and the influencing of attitude, opinion, and action. Lectures, discussions, and reports; viewing of selected films and television programs. ½ unit. Prerequisite: Speech 307 or consent of instructor. The prerequisite does not apply to students of library science who have obtained the necessary background through independent reading. MUELLER.

325. **Introduction to Psycholinguistics.** Same as Linguistics 325. An introductory survey of psychological and linguistic approaches to the study of communication. 1 unit. Prerequisite: An introductory course in linguistics or psychology. MACLAY.

344. **Public Opinion.** Same as Sociology 344. Opinion changes and control; propaganda; interest groups and opinion; critical review of methods of measurement. ½ unit. Prerequisite: Sociology 100, or Division of General Studies or Sociology 151. SIMON.

351. **Advanced Social Psychology.** Same as Psychology and Sociology 351. An integrative treatment of individual behavior variables in relation to group variables. ½ or 1 unit. Prerequisite: Sociology 201 or Psychology 201; Psychology 235 or Sociology 385, or a comparable statistics course. MCGRATH, I. STEINER.

352. **Attitude Theory and Measurement.** Same as Psychology and Sociology 352. A comprehensive survey of psychological theories of attitude organization and change, and a theoretical and methodological analysis of the various techniques used to measure attitude. These theories and methods are evaluated with respect to empirical research in the area. ½ or 1 unit. Prerequisite: Sociology 201 or Psychology 201; a course in statistics. FISHBEIN.

360. **Educational Uses of Television and Radio.** Same as Educational Psychology and Radio-Television 360. A study of television and radio as educational instruments, and standards necessary for such use; production, utilization, planning, and

evaluation; primary and secondary uses. Identification of the unique contributions and resources of the electronic media, as well as their limitations. Experimentation into new production and utilization techniques designed for educational uses. ½ unit. SKORNIA.

370. **Language, Culture, and Society.** Same as Anthropology and Linguistics 370. An examination of the social and cultural functions of language, with particular emphasis on the application of linguistic methods and findings to selected problems in the social sciences. ½ or 1 unit. CASAGRANDE.

COMPARATIVE LITERATURE

The program leading to the Master of Arts and Doctor of Philosophy degrees in Comparative Literature is designed to make possible a systematic study of subjects and problems common to several literatures. Its purpose is to enable students who have greater than average linguistic competence and preparation to explore (1) the interrelations of several literatures; (2) the main currents, periods, and movements in literary history; and (3) the theory of literature and criticism. The program is supervised by a committee made up of the heads and chairmen of the classical and modern language and literature departments. The student's program of study is supervised by an adviser in the department of his major interest. A student entering the program should have attained an undergraduate grade average of 4.0 and must present evidence of having acquired a command of two foreign languages. Some knowledge of Latin (or Greek) is highly recommended; Latin is necessary for students planning to specialize in the Medieval or Renaissance periods; it may be required for students specializing in Neo-classicism and the Enlightenment.

Master of Arts. A candidate for the Master of Arts in Comparative Literature must offer eight units of credit (general requirement of the Graduate College): these must include four units in one literature, Comparative Literature 401, and two units of credit in a second literature. The courses chosen from the second language and literature department must be approved by the adviser; and at least four of the courses, in addition to Comparative Literature 401, must be chosen at the 400 level. The candidate must also pass an examination based on a reading list and designed to test his knowledge of the literature of his main interest as well as his ability to interpret a literary or critical text. A master's thesis is not required, although the student may elect to offer one with the approval of his adviser.

Doctor of Philosophy. A candidate for the Doctor of Philosophy in Comparative Literature must fulfill the general requirements of the Graduate College including those specified above for the master's degree. He must choose at least four units of work from comparative literature seminars (451, 452, 461, 462). Four additional units of work at the 400 level are to be taken in courses regularly offered by the language and literature departments. The candidate is responsible for a knowledge of the history of the literature in one modern language. He must also select a period of major interest, and be responsible for a knowledge of two other literatures in this period, which are considered as minors. The periods may be either (1) Medieval, (2) Renaissance, (3) Neo-Classicism and the Enlightenment, or (4) The Modern Period. He must pass a preliminary examination (a three-part written examination, plus an oral examination), and present a thesis in which he has investigated a topic with ramifications of a comparative nature.

Inquiries concerning the program should be addressed to Professor François Jost, Director of the Graduate Program in Comparative Literature, 244 Lincoln Hall.

GRADUATE FACULTY

Professors: F. JOST (Director of the Graduate Program in Comparative Literature), A. O. ALDRIDGE, J. J. BATEMAN, J. J. CAMPBELL, J. T. FLANAGAN,

J. R. Frey, R. H. Green, H. R. Kahane, P. M. Mitchell, R. Montano.

Associate Professors: H. Knust, J. K. Simon.

COURSES FOR GRADUATES

401. Theory of Literature. The methods and objectives of the discipline of comparative literature. 1 unit. Prerequisite: Reading knowledge of two foreign languages; consent of instructor.

451. Seminar in Literary Movements. An investigation of the development and mutation of literary movements (classicism, romanticism, symbolism, etc.) through a study of critical texts and their reception in various countries. The subject of the seminar varies each semester, and it may be taken more than once for a total of three units. 1 unit.

452. Seminar in Literary Relations. An investigation of the impact of one literature upon another, or of some specific works upon others (the role of English literature in Continental Europe; the influence of Russian novelists on French and German writers, etc.). The subject of the seminar varies each semester, and it may be taken more than once for a total of three units. 1 unit.

461. Seminar in Literary Forms. A study of a form (the lyric, the novel, the drama, etc.) to discover its essential components in all the literatures studied and the significance of national variations. The subject of the seminar varies each semester, and it may be taken more than once for a total of three units. 1 unit.

462. Seminar in Literary Themes and Types. A study of a theme or type (the Faust myth, the romantic hero, etc.) to discover its essential components in all the literatures studied and the significance of national variations. The subject of the seminar varies each semester, and it may be taken more than once for a total of three units. 1 unit.

493. Special Studies. ¼ to 1 unit.

499. Thesis Research. Intended for students engaged in writing a thesis as a partial requirement for the A.M. or Ph.D. degree in Comparative Literature. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

313. The Divine Comedy. Same as Italian 313. An interpretation of Dante's *Divine Comedy* with special attention to its position in the medieval world; a knowledge of Italian is not required. ½ unit.

359. The International Folk Tale. Same as English 359. A study of the origin, distribution, and nature of the folk tale with special reference to themes and variants. Representative tales of various areas (Africa, Germany, Greece, India, Ireland, Japan, Norway) are analyzed, and North American Negro and Indian tales are discussed. ¾ unit.

363. Introduction to Comparative Literature, I. Same as Humanities 363. A one-year course in two parts, offering a survey of methods and goals of comparative literature, illustrated by representative examples taken from several literatures and studies of modern criticism. ¾ unit.

364. Introduction to Comparative Literature, II. Same as Humanities 364. Continuation of Comparative Literature and Humanities 363. ¾ unit.

COMPUTER SCIENCE

The Department of Computer Science offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy in Computer Science. There is opportu-

nity for specialization in circuit design, digital computer arithmetic, switching and automata theory, computer organization, computer applications in physical science, software systems and languages, numerical analysis, pattern recognition, and information retrieval.

The admission average is 4.0 for the last sixty semester hours of undergraduate work. Applicants with an average below 4.0 but above 3.75 are considered on an individual basis. Course prerequisites are twenty semester hours of electrical engineering, mathematics, or physics, including Computer Science 201 and 294, and one course in either Computer Science 301, 387, 391, or their equivalents. Since this is an interdisciplinary program, applicants whose programs are deficient in some of these areas are considered individually.

The requirements for the Master of Science degree in Computer Science include a thesis, in addition to the general requirements of the Graduate College.

The requirements for the Doctor of Philosophy degree in Computer Science include satisfactory achievement on a qualifying examination covering the areas of computer design, computer programming, and numerical analysis, in addition to the general requirements of the Graduate College.

Further details of this program are available from the Department of Computer Science.

The department provides service computing facilities for the educational and research programs of the University. At present, an IBM 7094/1401 system and an IBM 360/50-75 system are operated.

GRADUATE FACULTY

Professors: J. R. Pasta (Head of Department), L. D. Fosdick, D. B. Gillies, B. H. McCormick, S. Muroga, W. J. Poppelbaum, J. E. Robertson, D. L. Slotnick, J. N. Snyder (Associate Head of Department).

Associate Professors: C. W. Gear, T. A. Murrell, S. R. Ray.

Assistant Professors: M. Faiman, H. G. Friedman, D. J. Kuck, J. Nievergelt, R. S. Northcote, J. R. Phillips, P. E. Saylor.

COURSES FOR GRADUATES

400. Introduction to Automatic Digital Computing for Graduate Students. A beginning course covering the programming of digital computers using procedure oriented language. No graduate credit.

413. Computer Applications in Social Statistical Research. Same as Psychology and Sociology 413. Computer procedures for the analysis of sociological and psychological data, including probability matrices, dominance matrices, clique analysis, regression analysis, analysis of variance and covariance, canonical correlations, discriminant analysis, and factor analysis. 1 unit. Prerequisite: Sociology 387 or equivalent in statistics; may be taken concurrently with Sociology 387. Dickman.

414. Engineering Applications of Linear Graphs. Same as Electrical Engineering 414. Elementary theory of linear graphs, Euler graphs; incidence, cut-set and circuit matrices and their properties; realizability of cut-set, circuit and tree matrices; applications to network analysis and synthesis; signal flow graphs; applications to switching circuits and automata; communication networks. 1 unit. Prerequisite: Electrical Engineering 416; Mathematics 315 or 318.

456. Coding Theory. Same as Electrical Engineering 456. General discussion on coding theory with emphasis on the algebraic theory of cyclic codes; error-control procedures and circuits; applications to computers and data transmission systems. 1 unit. Prerequisite: Mathematics 317 or equivalent, or consent of instructor.

457. **Advanced Numerical Analysis.** Same as Mathematics 457. Ordinary differential equations: existence theory of Picard, one-step and multi-step methods, discretization error, convergence, stability, boundary value problems; integral equations. 1 unit. Prerequisite: Computer Science or Mathematics 387, or consent of instructor.

458. **Numerical Solution of Partial Differential Equations.** Same as Mathematics 458. The numerical solution of initial and boundary value problems for partial differential equations; topics include the approximation of differential operators by difference operators, the solution of large systems of linear equations by interative methods, and discussion of convergence and numerical stability. 1 unit. Prerequisite: Mathematics 455 or consent of instructor.

463. **Information Theory.** Same as Electrical Engineering and Mathematics 463. Mathematical models for information channels and sources; existence theorems for and construction of error-correcting codes. 1 unit. Prerequisite: Mathematics 361 or Electrical Engineering 433.

465. **Topics in Automata Theory.** Same as Electrical Engineering and Mathematics 465. Topics selected from mathematical systems and automata theory, decision problems, formal languages, decomposition theory, etc. 1 unit. Prerequisite: Computer Science, Electrical Engineering, or Mathematics 392, or consent of instructor.

481. **Threshold Logic.** Same as Electrical Engineering 481. Mathematical model of computer elements which work under threshold or majority principle; mathematical theory of threshold functions; realizability using a linear programming approach; network syntheses of majority principle devices. 1 unit. Prerequisite: Consent of instructor.

482. **Theory of Digital Computer Arithmetic.** Same as Electrical Engineering 482. This course emphasizes the use of redundancy in the representation of digits in order to increase the efficiency of computer arithmetic. Topics include multiplier recoding, division with redundantly represented quotients, and structural redundancy as implied by carry-save and signed-digit techniques. 1 unit. Prerequisite: Computer Science or Electrical Engineering 394.

485. **Advanced Theory of Magnetic and Optic Computer Memory Devices.** Same as Electrical Engineering 485. Theory of ferromagnetism and superconductivity applied to memory devices; light propagation in anisotropic media; modulators and deflectors; principles of laser operation. 1 unit. Prerequisite: Computer Science or Electrical Engineering 385.

487. **Theory of Approximation.** Same as Mathematics 487. General approximation theory in normed linear spaces with primary emphasis on functions defined on an interval, and periodic functions; existence and uniqueness theorems; characterization of Chebyshev approximants; degree of approximation; interpolation with emphasis on the quality of interpolants as approximants; use of approximations in computing. 1 unit. Prerequisite: Mathematics 318, 348, or consent of instructor.

490. **Individual Study.** Individual study or reading in a subject not covered in normal course offerings. ½ to 2 units. Prerequisite: Consent of instructor.

491. **Seminar in Computer Science.** Seminar on topics of current interest. Subjects will be announced in the Time Table. ½ to 1 unit. Prerequisite: Consent of instructor.

497. **Special Topics in Computer Science.** Lecture courses in topics of current interest. Subjects will be announced in the Time Table. ½ to 1 unit. Prerequisite: Consent of instructor.

499. **Thesis Research.** Section A, for master's degree candidates; Section B, for doctoral degree candidates. 0 to 4 units. Prerequisite: Consent of instructor.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Programming, Languages, and Computation. An introduction to mathematical models of programming languages and computation on a digital computer; phrase structure languages, particularly context free languages, and their syntactic analysis with application to translation; abstract models of digital computers and the computations which they can perform subject to various restrictions on control, memory, and time; unsolvability results for computations and languages. 1 unit. Prerequisite: Computer Science 201 or consent of instructor.

306. Machine Language and System Programming, II. Principles of programming; procedure and problem oriented languages—use and implementation; problems in system programming for input/output channels and time sharing. 1 unit. Prerequisite: Computer Science 201 or consent of instructor.

311. Mathematical Theory of Data Processing. Mathematical structure and automatic processing of extensive files of data are developed employing methods from statistics, graph theory, and information theory. Topics discussed include: the selective screening and classification of data (pattern recognition, machine abstracting, optimum encoding, least square adjustment of data); and file organization and maintenance (information retrieval, indexing, and scheduling). 1 unit. Prerequisite: Computer Science 101 or consent of instructor.

365. Digital Computer Methods for Statistical Data Processing. Same as Agronomy 365. A study of computing methods for efficient utilization of high-speed equipment in the processing of statistical data. Emphasis is on principles of application of computing equipment to the solution of statistical problems. Numerous examples are given and actual problem solution by the student is accomplished. 1 unit. Prerequisite: Computer Science 101 and a course in statistics or statistical methods, or consent of instructor.

385. Theory of Semiconductor Computer Devices. Same as Electrical Engineering 385. Crystal conduction; large signal d-c and transient behavior of semiconductor devices; charge storage theory, phase plane diagrams, tolerance optimization and noise theory; integrated circuits technology: masking, oxidizing, and etching; emphasis on development of device-theoretical background for computer logic design. ¾ or 1 unit. Prerequisite: Computer Science or Electrical Engineering 294, or consent of instructor.

387. Introduction to Numerical Analysis. Same as Mathematics 387. The main topics discussed in this course are error analysis and algorithms for the solution of equations, the computation of eigenvalues and eigenvectors, and numerical approximation of functions. 1 unit. Prerequisite: Computer Science 101; calculus and a knowledge of elementary matrix algebra, or consent of instructor.

391. Boolean Algebra and Switching Theory. Same as Mathematics and Electrical Engineering 391. Boolean algebra with applications to sets, logic, electronic and relay combinational circuits; Karnaugh and Quine-McCluskey minimization procedures with applications; introduction to sequential circuits. 1 unit. Prerequisite: Consent of instructor.

392. Introduction to Automata Theory. Same as Mathematics and Electrical Engineering 392. Semigroups, partially ordered sets, and other algebraic systems; asynchronous machines; abstract synchronous machines and their properties; regular sets; decomposition theory. ½ or 1 unit. Prerequisite: Electrical Engineering, Computer Science, or Mathematics 391, or consent of instructor.

393. Digital Computer Circuit Design. Same as Electrical Engineering 393. Design of switching circuits and systems taking into account properties of currently available diodes, transistors, and related circuit elements; applications to slow-speed as well as high-speed computer circuits and data handling links; component toler-

ance, circuit reliability, and cost factors are considered. 1 unit. Prerequisite: Electrical Engineering 342; Computer Science or Electrical Engineering 294 or 391; or consent of instructor.

394. Logical Design of Automatic Digital Computer Circuits. Same as Electrical Engineering 394. A course in the design of automatic digital computers. Major emphasis is on logical structure of components and the interrelations necessary for automatic operation. 1 unit. Prerequisite: Electrical Engineering 294; consent of instructor.

DAIRY SCIENCE

The Department of Dairy Science offers graduate work leading to the Master of Science and Doctor of Philosophy. This work is given in five chief fields of specialization: dairy bacteriology and microbiology, dairy biochemistry, dairy cattle feeding and nutrition, dairy cattle breeding and genetics, and physiology of lactation and reproduction.

For admission to full standing, an applicant's undergraduate grade-point average must be at least 3.75.

For a major in dairy science for either advanced degree, students must select, with the advice of the head of the department, a faculty adviser in the separate area of study desired. Candidates for the Master of Science must complete one-half unit of seminar and two units of thesis research. For the Doctor of Philosophy, one and eight units, respectively, of these courses are required. Other course requiements depend upon the area of study in which the student specializes and upon his background training. Information concerning such requirements may be obtained from the departmental office.

Candidates for the Master of Science are expected to complete an acceptable thesis unless the Dean of the Graduate College waives this requirement. All students expecting to continue graduate studies should fulfill the thesis requirements for the master's degree. A comprehensive examination concerning the thesis and the general field of dairy science also is required.

For a minor in dairy science, students should select an adviser in this area of study to determine the specific courses required. For the Master of Science, the minimum requirements for a first minor are two units in dairy science, and for a second minor, one unit in dairy science.

For the Doctor of Philosophy, the minimum requirements for a sole minor are four units of dairy science, of which two units must be in 400-level courses; for a first minor, three units in dairy science; and for a second minor, two units in dairy science.

GRADUATE FACULTY

Professors: G. W. Salisbury (Head of Department), H. P. Broquist, R. E. Brown, M. P. Bryant, K. E. Harshbarger, R. L. Hays, K. A. Kendall, B. L. Larson, R. W. Touchberry, M. J. Wolin.

Associate Professors: J. H. Byers, C. L. Davis, J. R. Lodge.

Assistant Professor: C. N. Graves.

COURSES FOR GRADUATES

402. The Microbiology and Physiology of Ruminant Nutrition. The physiological and microbiological aspects of ruminant digestion and their influence on the metabolism of the extraruminal tissues; interpretation of nutritive requirements in terms of rumen microbial activities and evaluation of research techniques. ¾ unit. Prerequisite: Chemistry 350, 355, or equivalent. Brown, Bryant.

408. **Physiology of Lactation.** The anatomy and endocrinology of mammary development; the environmental, endocrinological, and biochemical factors which affect the yield and composition of milk. ½ to 2 units. HAYS.

411. **Population Genetics and Animal Breeding.** Same as Animal Science 411. The mathematical theory of population genetics and its application to the improvement of farm animals; results of different systems of mating and the expected gains from different methods of selection. 1 unit. Prerequisite: Dairy Science 110 or equivalent. A knowledge of elementary algebra is essential. TOUCHBERRY.

412. **Advanced Endocrinology.** Same as Animal Science, Physiology, and Zoology 412. Seminar, lectures, student reports, and discussions of recent advances in endocrinology. This course may be repeated for credit not to exceed a total of two units. ½ unit. Prerequisite: Consent of instructor. GORSKI, NALBANDOV.

430. **Physiology of Mammalian Germ Cells.** A literature and laboratory course covering the recent theories and developments on the formation, transportation, and livability of spermatozoa and ova within the body, and their metabolism and preservation *in vitro*. 1 unit. Prerequisite: Dairy Science 330, Animal Science 406, and Chemistry 350, or consent of instructor. LODGE, SALISBURY.

440. **Design and Analysis of Biological Experiments, I.** Same as Agronomy, Animal Science, Forestry, Horticulure, and Veterinary Medical Science 440. A study of statistical methods as tools for research. Principles of designing experiments and the methods of analysis for various kinds of designs are considered from the viewpoint of when and how to use the available simpler designs and analytical methods. 1 unit. Prerequisite: Consent of instructor. SEIF.

441. **Design and Analysis of Biological Experiments, II.** Same as Agronomy, Animal Science, Forestry, Horiculture, and Veterinary Medical Science 441. A continuation of Dairy Science 440 moving into the more complex designs and methods of analysis. 1 unit. Prerequisite: Dairy Science 440 or equivalent. CARMER.

450. **Dairy Bacteriology.** Assigned laboratory problems in dairy bacteriology. ½ to 2 units. Prerequisite: Ten hours of advanced microbiology and/or chemistry; consent of instructor. BRYANT, WOLIN.

481. **Animal Biochemical Laboratory Techniques.** Theory and application of biochemical laboratory techniques to research in the animal-oriented biological sciences. Isolation, characterization, and analysis of biological compounds including enzymes, metabolic intermediates, and cellular components; determination of metabolic pathways and processes. 1 unit. Prerequisite: Chemistry 350 and 355.

490. **Diary Science Seminar.** Current literature relating to various phases of dairy science. ½ unit. Prerequisite: Graduate major or minor in dairy science. SALISBURY.

493. **Special Problems.** Individual investigations in any phase of dairy science. ½ to 2 units. BROQUIST, BROWN, BRYANT, BYERS, DAVIS, GRAVES, HARSHBARGER, HAYS, KENDALL, LARSON, LODGE, SALISBURY, TOUCHBERRY, WOLIN.

499. **Thesis Research.** 0 to 4 units. BROQUIST, BROWN, BRYANT, BYERS, DAVIS, GRAVES, HARSHBARGER, HAYS, KENDALL, LARSON, LODGE, SALISBURY, TOUCHBERRY, WOLIN.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Special Problems.** Supervised research on any phase of dairy science, including bacteriology and microbiology, biochemistry, feeding and nutrition, genetics, and physiology. ½ or 1 unit. Prerequisite: Approval of head of department.

Broquist, Brown, Bryant, Byers, Davis, Graves, Harshbarger, Hays, Kendall, Larson, Lodge, Salisbury, Touchberry, Wolin.

305. Genetics and Animal Improvement. Same as Animal Science 305. The principles of heredity and their application to the problem of animal improvement. ¾ unit; S, ½ unit. Prerequisite: Dairy Science 110 or equivalent. Rasmusen, Touchberry.

320. Nutrition and Digestive Physiology of Ruminants. Same as Animal Science 320. The physiology and microbiology of digestion in the ruminant and biochemical pathways of utilization of the absorbed nutrients for productive purposes. ¾ unit. Prerequisite: Dairy Science or Animal Science 221.

330. Reproduction and Artificial Insemination of Farm Animals. Same as Animal Science 330. The anatomy and physiology of reproduction in farm animals, the principles of artificial insemination, and the factors affecting conception in natural and artificial breeding. ¾ unit; S, ½ unit. Prerequisite: Zoology 104; Dairy Science 100 or Animal Science 100. Graves, Lodge.

334. Marketing Diary Products. Same as Agricultural Economics 334. Economic interrelationships of various dairy products; collective bargaining; federal milk orders, mark-up laws, marketing quotas, and other governmental regulations; lowering distribution costs; factors affecting demand and consumption; expanding markets for dairy products. Inspection trip; estimated expense, $5.00. ¾ or 1 unit. Prerequisite: Agricultural Economics 230, an elementary marketing course, or twelve hours of dairy science or dairy technology. Bartlett.

381. Diary Biochemical Laboratory Methods. Theory and application of dairy biochemical laboratory methods: proximate analysis, spectrophotometry, chromatography, protein separation, microtechniques, microrespiration, and others. 1 unit. Prerequisite: Quantitative analysis; organic chemistry; consent of instructor. Biochemistry is recommended. Larson.

DANCE

The Dance Division offers a program of graduate study leading to the Master of Arts in Dance. This program offers advanced work in choreography, dance production, and pedagogy, with emphasis on the related fields of art, music, and theatre.

Admission requirements for a major in this field are: (1) a minimum grade-point average of 3.5; (2) twenty-four semester hours of approved undergraduate credit in dance (at least eight hours), art, music, theatre, and physical education; (3) thirty-six semester hours in humanities (literature, language, and philosophy), natural sciences (biological and physical sciences), and social sciences (history, political science, psychology, anthropology, sociology, education). Applicants lacking a portion of the prerequisites under item (2) may substitute certified experience in dance not to exceed eight semester hours.

Satisfaction of the general requirements for admission to the Graduate College and to this program does not in itself necessarily qualify the student as a degree candidate. The Dance Division also reserves the right to accept for advanced study only those students whose preparation in dance has been obtained in certain approved institutions.

Of the eight units required for the Master of Arts, a minimum of four must be in dance, or (subject to the approval of the supervisor) in dance and related areas such as art, music, theatre, and speech; two units must be in one or more of the following fields: English, history, philosophy, anthropology, psychology, sociology, radio-television. The remaining two units are for the presentation of an acceptable thesis (Dance 499) and the accompanying noncredit course, Dance 490, Seminar. The thesis may be waived, with the approval of the adviser, but in lieu thereof the

candidate must submit two units of course work (total of eight units), plus a recital of solo and group dances which he has choreographed and staged.

Not later than midpoint in the student's program, his work is reviewed in order to determine his status in terms of progress, ultimate completion, and awarding of the degree. The Dance Division may extend the residence requirement (or increase the total requirements) at this time or any other time, if this seems warranted.

GRADUATE FACULTY

Professor: Margaret Erlanger.

Assistant Professors: A. R. Thomas, W. W. Ward, Jr.

COURSES FOR GRADUATES

400. Problems in Dance Education. Basic historical, philosophical, and scientific foundations and developments in dance education; teaching methods; development of compositional problems; creative methods of instruction; organizational problems of dance groups and public dance performance. 1 unit. Prerequisite: Dance 243 or 244, or equivalent. Staff.

401. Choreography. Experience in choreographing a minimum of one solo and one group composition to be presented at the end of the semester. ½ to 2 units. Prerequisite: Dance 345 or equivalent. Students may re-register for a maximum of two units with the permission of the Dance Division. Staff.

490. Dance Seminar. Student presentation of thesis reports in dance; informal discussions, demonstrations, lectures, and critical analysis of current problems in dance by professional guests. No credit. Staff.

499. Thesis Research. Preparation of theses in dance. ½ to 2 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

340. History of Dance. A survey course tracing dance from its beginnings in primitive societies to its present art form. ½ unit. Prerequisite: Consent of instructor. Staff.

345. Dance Production Workshop. Experience in choreography and production of group compositions with special emphasis on staging, lighting, and costuming. ½ unit. Prerequisite: Dance 164 or equivalent; consent of instructor. Staff.

346. Theory and Philosophy of Dance. A study of the relationship of aesthetic principles and dance theory to a philosophy of dance in education and of dance as a performing art. ½ unit. Prerequisite: Consent of instructor. Staff.

ECONOMICS

The Department of Economics offers graduate work leading to the Master of Arts, Master of Science, and Doctor of Philosophy.

A student who applies for admission to graduate study in economics must have a grade-point average of 4.0 or higher. Students with averages between 3.75 and 4.0 are considered on an individual basis. Applicants must have completed fifteen hours of undergraduate work in economics or have approval of the Director of Graduate Studies. The department recommends that the results of the Graduate Record Examination Aptitude Test accompany application for admission to the Graduate College. Information concerning the dates and places for taking this examination may be secured by writing to the Educational Testing Service, Box 955, Nassau Street, Princeton, New Jersey 08540.

The candidate for an advanced degree in economics may specialize in the following fields of economics: economic theory, history of economic thought, monetary theory and policy, public finance and taxation, growth and development, international economics, labor economics, economic history, comparative economic systems, transportation, econometrics, urban and regional economics, and industrial organization.

Master of Arts or Master of Science. The following requirements must be met:

(1) Economic Theory. Two units of course work, consisting of 400-401, or 402-403; if the student has had 300-301 or their equivalent, he must take 402-403.

(2) Statistics. Proficiency in statistical analysis. This requirement may be met by taking Economics 470 or by passing a proficiency examination.

(3) History of Economic Thought or Economic History. One unit in either field at the 400 level. Two units are recommended.

(4) Course work beyond that required to bring the total to eight units, two of which may be master's thesis work, or successful completion of the written qualifying examination for the doctorate.

Doctor of Philosophy. The following requirements must be met:

(1) Economic Theory. Economics 402-403, plus one additional 400-level course in advanced economic theory.

(2) Statistics. The same demonstration of proficiency as for the master's degree.

(3) History of Economic Thought and Economic History. Passing a written preliminary examination in these subjects with one unit of 400-level course work in each.

(4) Specialized Fields. The student must select three additional fields, two of which must be in economics, and the third outside the department. At least two units of graduate work in courses in each field selected are required.

(5) Additional units to bring the total to twenty-four, of which eight must be doctoral dissertation units.

The candidate is required to pass examinations in two foreign languages, an oral and written preliminary examination prior to beginning dissertation research, and an oral final examination covering his research.

GRADUATE FACULTY

Professors: M. Frankel (Chairman of Department), V L. Bassie, R. Brandis, H. J. Brems, J. F. Due, R. Ferber, D. P. Flanders, R. W. Harbeson, D. R. Hodgman, G. G. Judge, D. L. Kemmerer, E. B. McNatt, W. H. McPherson, D. W. Paden, J. B. Parrish, J. D. Phillips, P. J. Wells.

Associate Professors: Grace Beckett, H. W. Folk, R. W. Gillespie, F. M. Gottheil, A. J. Heins, W. W. McMahon, H. O. Nourse, R. W. Resek, P. Schran, F. R. Shupp, C. M. Sprenkle, S. W. Steinkamp, Janet L. Weston, T. A. Yancey.

COURSES FOR GRADUATES

400. **General Economic Theory.** Emphasis in this course is placed on micro-economic theory. The principal topics include: a review of value and distribution theory, the theory of choice by household, and firms general micro-economic theory; and theoretical developments of current interest. Attention is given to empirical studies intended to affirm or disaffirm economic principles. Intended for minors in economics and others who have a minimum preparation for graduate study in economics. 1 unit. Prerequisite: Economics 102, 103, or 108. Flanders.

401. **General Economic Theory.** Emphasis in this course is placed on macro-economic theory and the relationship of economics to the other social sciences. The principle topics include: a review of Keynesian macro-economic theory, formal growth theory, selected business cycle theory, the theory of socio-economic change, and

an outline of the differentiation and integration of economics and other social sciences. Intended for minors in economics and others who have a minimum preparation for graduate study in economics. 1 unit. Prerequisite: Economics 102, 103, or 108. FLANDERS, STAFF.

402. Economic Theory. This course develops modern micro-economic theory: utility functions and demand; production functions and cost; linear programming; price and nonprice policy by the firm; market equilibria; income distribution; general equilibrium including input-output analysis. The course is given in two sections, one offering a primarily mathematical presentation, the other, a primarily literary presentation. 1 unit. Prerequisite: Economics 300, 301, or equivalent; for the mathematical section, a knowledge of algebra and calculus. STAFF.

403. Economic Theory. This course develops modern macro-economic theory; the Keynesian model of employment, interest, and money; its extension to international trade; fiscal policy and macro-economic theory of distribution; the consumption function; the theory of growth and cycles in terms of difference and differential equations. This course is given in two sections, one offering a primarily mathematical presentation, the other, a primarily literary presentation. 1 unit. Prerequisite: Economics 300, 301, or equivalent; for the mathematical section, a knowledge of algebra and calculus. STAFF.

406. History of Economic Thought. An analysis of economic thought from the Physiocrats to the present; the materials selected are evaluated both as reflections of their times and as contributions to contemporary economic thought. 1 unit. Prerequisite: Economics 300 and 301, or equivalent. BRANDIS, GOTTHEIL.

408. Philosophical Problems in Economics. The study of philosophical problems in economics, with some emphasis on the methodology and epistemology of economic theory. The views of leading economists are used to show the development of broad philosophical problems of economic theory, the relation of theory and certain of its applied areas, and the relation of economics to other selected disciplines. These problems are treated in the light of modern scientific philosophy. 1 unit. Prerequisite: One unit either in economic theory or in the history of economic thought.

410. Price and Distribution Theory. A research-oriented seminar in micro-economic theory. Major topics treated include: comparative static analysis of demand, production, and the theory of markets; dynamic equilibrium; market dynamics. Sub-topics include axiomatics of preferences; ordinal and Bernoullian utility, revealed preference, and the interdependence of preferences; multiperiod production, utility, and consumption; the aggregation of micro-economic relationships; expectations and response lags; analysis of changing market structures; game theory. Offered in 1968-1969 and in alternate years. 1 unit. Prerequisite: Economics 402 and 470, or equivalent.

411. Capital and Interest Theory. A comprehensive and critical examination of the theory of capital and interest as the subject has been developed by the leading English and continental writers. Special attention is given to the optimal investment decision of the firm, capital accumulation and the efficient utilization of society's resources, and to the relation between capital and interest. Offered in 1969-1970 and in alternate years. 1 unit. Prerequisite: Economics 403 or consent of instructor. BREMS, SPRENKLE, WELLS.

412. Advanced Aggregate Income Theory. An analysis of the theory of income and employment with emphasis upon the measurement of income and product, money flows, and the relationship between input and output in the economy. Offered in 1969-1970 and in alternate years. 1 unit. Prerequisite: Economics 403 or consent of instructor. BREMS, PADEN, WELLS.

413. Consumption Theory. The theory of consumer behavior in modern economic analysis. Utility analysis at the micro level, consumer interdependence and prob-

lems of aggregation, econometric tests, aggregate consumption analysis in static and dynamic contexts, and the implications of the theory of consumer behavior for cyclical movements and economic growth. Offered in 1968-1969 and in alternate years. 1 unit. Prerequisite: Economics 400 or 402, or consent of instructor. FERBER, MCMAHON.

414. **Public Finance.** Analysis of government expenditures and decision making; the budgetary process; fiscal policy; government borrowing and debt management; intergovernmental fiscal relations; pricing of government services; public finance in developing economies. 1 unit. Prerequisite: Six hours of economics. DUE, HEINS.

415. **Economics of Taxation.** Principles of taxation; incidence and distribution of tax burden; economic analysis of the major taxes: the personal and corporate income taxes, sales and excise taxes, property tax, and others; taxation and economic development. 1 unit. Prerequisite: Six hours of economics. DUE, HEINS.

420. **Monetary Theory.** A critical examination of monetary theories and their neoclassical antecedents. Among the topics considered are the quantity theory, liquidity preference, the demand for money, velocity, theories of the level and term structure of interest rates, asset theory, and money in static and dynamic macro-general equilibrium models. 1 unit. Prerequisite: A course in income and employment theory or consent of instructor. HODGMAN, SPRENKLE.

421. **The Theory of Monetary Policy.** Theories of central banking, debt management, financial intermediaries, and the monetary behavior of firms and households are used to explore current issues in the theory of monetary policy. Current empirical research is reviewed with particular emphasis on econometric studies of monetary behavior. 1 unit. Prerequisite: A course in money and banking, in macroeconomic theory, calculus, and statistics, or consent of instructor. HODGMAN, SPRENKLE.

425. **Macro-Accounting.** Same as Accountancy 455. An examination of the fundamental concepts underlying the attempt to measure the economic activities of macro-units; similarities and contrasts of accounting problems, theoretical and practical, of the business enterprise and of national or regional units in relationship to existing systems of accounting measurement; macro-accounting statements and analyses; usefulness of macro-accounting techniques and data in evaluating national and regional goals, 1 unit. Prerequisite: Intermediate macro-accounting theory or consent of instructor.

428. **International Trade Theory.** The neoclassical theory of international trade is developed and then used for the analysis of tariffs, customs, unions, and the effects of trade on the distribution of income and welfare. The relations between the balance of payments and national income are analyzed and used to study the role of income changes combined with price changes in the balance of payments adjustment process. 1 unit. Prerequisite: Economics 300 and 301, or equivalent. GILLESPIE.

429. **International Trade Policy.** Concepts of balance of payments equilibrium, the foreign exchange market and the theory of capital movements; current problems and policies related to balance of payments desequilibrium, trade policy, and the functioning of the international monetary system. 1 unit. Prerequisite: Economics 300 and 301, or equivalent. CUMMINGS, GILLESPIE.

436. **American Economic History.** Colonization, westward movement, agriculture, transportation, industrial revolution, trust movement, slavery, labor conditions and organizations, capital growth, money and banking, foreign and domestic commerce, and social progress. Material chiefly since 1790. Not open to students who have had Economics 236. 1 unit. KEMMERER.

438. **Economic History of Europe.** The major lines of development since 1450; comparative study of forces and institutions inimical or favorable to growth; selected

readings on organization of economic activity, role of governments and the entrepreneur, commercial policy, monetary systems, land tenure, process of capital formation, industrialization, etc. 1 unit. Prerequisite: Consent of instructor.

440. Labor Economics. Same as Labor and Industrial Relation 440. A survey of recent trends in the labor force, of real and money earnings, and of the distribution of national income. This review of recent trends in these areas is used as the basis for a critical economic analysis of contemporary English and American wage theory. 1 unit. Prerequisite: A minimum of six hours of economics.

441. Labor Economics. Same as Labor and Industrial Relations 441. The economic issues and implications involved in hours of work, employment and unemployment, and trade union institutionalism (the impact of the trade union upon the basic institution of a free enterprise economy). Emphasis in all cases is upon the development of appropriate public policy. 1 unit. Prerequisite: A minimum of six hours of economics.

442. Collective Bargaining. Same as Labor and Industrial Relations 442. The development of a theory of the continuing interactions between unions and management which define and modify the role of each and the terms of employment. Appropriate social science concepts are used. Emphasis is on the negotiating process, the structure of bargaining, and such issues as wages, worker security, and management authority as well as on the interactions between the parties and governmental process. 1 unit. Prerequisite: Consent of instructor.

443. Problems and Practices of Labor Dispute Settlement. Same as Labor and Industrial Relations 443. Seminar in the policies and practices of labor contract administration; comparative study of the fundamentals of grievance handling, analysis of mediation and fact-finding techniques; and special emphasis on the use of arbitration as a means of reducing industrial conflict. 1 unit. Prerequisite: Consent of instructor. McPherson.

444. Economics of Manpower Resources. Same as Labor and Industrial Relations 444. Emergence of the manpower resource issue; population as a resource base: the labor force; measurement and characteristics, behavior under changing income, employment, technology; women as the dynamic factor in labor force growth; problems of utilization of labor force components; intellectual resources, older workers, manual, white collar, Negro, marginal forces; issues of national manpower policy. 1 unit. Prerequisite: Consent of instructor. Parrish.

447. Labor Union Organization and Administration. Same as Labor and Industrial Relations 447. Analysis of the structure, functions, and government of the modern American trade union movement. Provides a survey of the environmental factors, objectives, and action programs with considerable emphasis on economic as well as internal institutional factors, including the roles of leaders, policy determination and execution, jurisdictional disputes, and governmental regulations. 1 unit. Prerequisite: Major in social science or consent of instructor. Garman.

450. The Economics of Development and Growth. Review and analysis of the theories and patterns of growth in developed and underdeveloped economies. The problems and methods of measuring growth are considered, the variables thought to be strategic in the growth process are critically examined, and the policy implications of different theories are explored. 1 unit. Prerequisite: Economics 300 and 301, or equivalent. Frankel.

451. The Developing Economies. An analysis of the newly-developing economies, with emphasis on institutional factors affecting development, and economic policy relating to development. 1 unit. Prerequisite: Economics 450. Staff.

455. Comparative Economic Systems. A comparative analysis of the structures and policies of market-directed and planned economies. 1 unit. Prerequisite: Economics 103 or 108 or equivalent. Gottheil.

457. **Economic Planning in the Soviet Union and Eastern Europe.** An intensive examination of the structure and performance of the Soviet and the East European economies, emphasizing analysis of the main theoretic and operational dimensions of economic planning; choice, design, and efficacy of central planning instruments are evaluated from both theoretical and historical perspectives. 1 unit. Prerequisite: Economics 357, 450, or 455, or a reading knowledge of Russian. MILLAR.

460. **Location Theory.** The theory of location of economic activity in modern economic analysis; production and location theories are synthesized and applied to regional structure and interregional and international trade and development. A student can not receive graduate credit for both Economics 360 and 460 or 461 1 unit. Prerequisite: Economics 300 and 301, or equivalent. NOURSE.

461. **Urban and Regional Economic Development.** Measurement and analysis of interregional differences in economic growth. A student cannot receive graduate credit for both Economics 360 and 460 or 461. 1 unit. Prerequisite: Economics 300 and 301.

467. **Economic Activity Analysis.** Selected topics in economic theory are analyzed with the aid of mathematical programming, input-output analysis, set theory, and game theory. Existence, optimality and stability conditions for static and dynamic general equilibrium phenomena are emphasized, and such related topics as welfare economics and capital accumulation may be treated. Offered in 1969-1970 and in alternate years. 1 unit. Prerequisite: Consent of instructor. BREMS, SHUPP.

468. **Economic Dynamics.** The course is devoted to the study of the behavior of aggregate output and income over time. Mathematical models are developed of long-run growth and short-run cycles, as well as the interactions between the two. Familiarity with first-order, second-order, and higher order single difference equations as well as systems of difference equations is acquired in the course. Offered in 1968-1969 and in alternate years. 1 unit. Prerequisite: Economics 403. BREMS.

470. **Economic Statistics.** Classical statistics and regression analysis; descriptive statistics, probability, point and interval estimation, decision theory, variance analysis, linear regression, and least squares estimates. 1 unit. Prerequisite: Consent of instructor.

471. **Economic Statistics.** Part 1: the construction of econometric models; characteristics of models and choice of estimating methods; estimates of parameters by various methods. Part 2: Bayesian statistics and decision theory. 1 unit. Prerequisite: Economics 470 or equivalent. YANCEY.

473. **Economic Forecasting.** Forecasting techniques; analysis of important forecasting situations in terms of strategic forces and relationships; the place of judgement in evaluating current information, selecting critical factors, and appraising the validity of analytical techniques. Offered in 1968-1969 and in alternate years. 1 unit. Prerequisite: Economics 171 and 312 or 373 or equivalent. BASSIE.

474. **Operations Research.** A study of quantitative techniques useful in economic analysis and decision making. Mathematical programming, dynamic programming, queueing theory, renewal theory, and simulation methods are applied to economic control systems with special emphasis on the problems of the firm. Offered in 1969-1970 and in alternate years. 1 unit. Prerequisite: Mathematics 363 and Economics 374 or equivalent. SHUPP.

476. **Econometrics, I.** Estimation of parameters for single equation models; tests of hypotheses and confidence regions for regression models; large sample theory in

single equation models; Bayesian statistics in regression models. 1 unit. Prerequisite: Mathematics 315 and 363. RESEK, YANCEY.

477. **Econometrics, II.** Specification of models with systems of simultaneous equations; identification problem, distributed lag models, K-class estimators, maximum likelihood estimators, three stage least squares, and effects of specification errors are considered. 1 unit. Prerequisite: Economics 476. RESEK, YANCEY.

479. **Research Seminar in Quantitative Economics.** Significant work in the area of quantitative economics is reported and explored by members of the instructional staff, by guest speakers from academic, governmental, and industrial centers, and by graduate students in the second year of their work who are assigned projects. Offered in 1968-1969 and in alternate years. 1 unit. Prerequisite: The equivalent of one year of graduate statistics (theoretical or applied), calculus, and the equivalent of one year of mathematical economics. FERBER.

480. **Seminar in the Relations of Government and Business.** Discussions and individual research in selected problems of economic policy arising from the interrelations of government and business. 1 unit.

481. **Seminar in the Relations of Government and Business.** Discussions and individual research in selected problems of economic policy arising from the interrelations of government and business. 1 unit.

484. **Economics of Transportation.** A study of the principal economic problems arising in connection with the development and regulation of railroads and other modes of transport. 1 unit. HARBESON.

485. **Economics of Transportation.** A study of the principal economic problems arising in connection with the development and regulation of railroads and other modes of transport. 1 unit. HARBESON.

490. **Individual Study and Research.** Directed reading and research. ½ to 1 unit. STAFF.

499. **Thesis Research.** Preparation of thesis required of all students writing master's or doctor's theses in economics. 0 to 4 units; S, 0 to 2 units. Master's theses, FLANDERS; doctor's theses, FRANKEL.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Intermediate Micro-Economic Theory.** Micro-economic analysis including value and distribution theory. Topics include the analysis of demand, the theory of the firm and the industry, and the analysis of the pricing of the factors of production. Each topic is integrated in a micro-general equilibrium context which builds toward explaining the resource allocation process. ½ unit. Prerequisite: Economics 103 or 108. Students may not receive credit for both Economics 200 and 300. STAFF.

301. **Intermediate Macro-Economic Theory.** The modern theory of the determination of the level and rate of growth of income, employment, output, and the price level. Alternate fiscal and monetary policies to facilitate full employment and economic growth are discussed. Prerequisite: Economics 103 or 108. ½ unit. STAFF.

302. **Economic Analysis.** An introduction to the theory of income and employment, price and allocation, and instability and growth. S; ½ or 1 unit. Prerequisite: Economics 103 or 108, enrollment in National Science Foundation Summer Institute in Economics, or consent of instructor. PADEN.

306. **History of Economic Thought.** A study of the development of economics. Contributions of schools of thought and individual writers are examined in their

settings and as they influenced economic thought and national policy. ½ unit. Prerequisite: Economics 103 or 108.

312. **Economic Dynamics and Growth.** An analysis of the causes of economic instability; the requirements for economic growth in the national economy, and a consideration of public policy relating to instability and growth. ½ or 1 unit. Prerequisite: Economics 108, or 103 and 301.

313. **Economics of Consumption.** Same as Home Economics 313. An analysis of the macro and micro aspects of consumption. ½ or 1 unit. Prerequisite: Economics 102 or 108; a course in applied statistics. Dunsing.

329. **International Trade Policy.** Analysis of the trade policies of selected countries, with particular reference to the United States; study of the relationships between international trade policy and the theory of international trade and finance. ½ or 1 unit. Prerequisite: Economics 103 or 108. Beckett.

335. **American Financial History.** American monetary history and the development of the present monetary system, the rise of commercial, investment, and central banking and of other financial institutions, and the financing of government, especially of major wars. ½ or 1 unit. Prerequisite: Finance 250. Kemmerer.

337. **Economic History of American Agriculture.** Same as Agricultural Economics and History 337. The development of American agriculture from early colonial times to the present. Emphasis on regional development, evolution of methods and equipment, trends in marketing and credit, and the making of federal farm policy. ½ or 1 unit. Prerequisite: A college-level course in basic economics or American history.

342. **Economics of Social Security.** Same as Labor and Industrial Relations 342. A critical analysis of the economic issues and problems involved in our legislative efforts to reduce the economic risks of unemployment, old age dependency, and industrial injuries. ½ or 1 unit. Prerequisite: Economics 103 or 108.

343. **Economics of Trade Unionism and Collective Bargaining.** Theory of the labor movement, union growth and the maturity doctrine, union wage determination and implications for income distribution and national wage-price policy, adjustment to changing technology, strategies in collective bargaining, problems and policies of government intervention. ½ or 1 unit. Prerequisite: Economics 103 or 108 and 240.

344. **The Law and Labor.** Same as Labor and Industrial Relations 344. An economic analysis of the problems and issues arising out of the legislative and judicial efforts to define the rights, duties, and responsibilities of labor organizations and management in the field of industrial relations. ½ or 1 unit. Prerequisite: Economics 103 or 108; Economics 240.

345. **Economics of Manpower.** Manpower training in economic growth, labor force characteristics, occupational structure and future manpower requirements, job information networks, economics of discrimination and underutilization, national manpower policies and programs, private industry and union manpower planning. ½ or 1 unit. Prerequisite: Economics 103 or 108.

349. **Senior Seminar in Labor Economics.** Pre-professional capstone course intended to unify other courses in labor economics and closely related fields. Included are studies of research techniques and sources; individual readings in current literature; preparation of research reports and papers; consideration of professional employment opportunities and graduate study in labor economics and industrial relations. ½ or 1 unit. Prerequisite: Economics 240; consent of instructor. Parrish.

350. **The Developing Economies.** An analysis of the economic problems associated with newly developing nations. Emphasis is placed on a study of their economic

structures, their factor scarcities, and their programs for development. Not open for graduate credit for graduate candidates in economics. Graduate credit is not given for both Economics 350 and 450 or 451. ½ or 1 unit. Prerequisite: Economics 108 or 102 and 103.

352. **Economic Development in Latin America.** A study of economic activity and the process of diversification and industrialization in Latin America, with comparative analysis of selected countries. ½ or 1 unit. Prerequisite: Economics 103 or 108, or consent of instructor. BECKETT.

353. **Economic Development in India and Southeast Asia.** Analysis of plans and progress toward economic development in India and Southeast Asia; economic characteristics of the area and their significance for economic development. ½ or 1 unit. Prerequisite: Economics 103 or 108, or consent of instructor. CUMMINGS.

357. **The Soviet Economy.** Analytical survey of Soviet economic development; structure and performance of the economy; problems of planning and control. ½ or 1 unit. Prerequisite: Economics 103 or 108, or consent of instructor. HODGMAN.

358. **The Economy of China.** Discussion of changes in the patterns of production, exchange, and distribution in Communist China, with emphasis on their relation to social transformation. Survey of Chinese economic history over the past century, dealing with the institutional background to and the structure of economic activities in China. ½ or 1 unit. Prerequisite: Economics 103 or 108, or consent of instructor. SCHRAN.

360. **Regional Economic Development.** A survey of the theory and problems of regional economic development, including regional accounts, interregional income and trade theory, principles of the location of economic activity, theories of regional growth, and public policy for development of regions. A student receiving credit for Economics 360 may not receive credit for Economics 460 or 461. ½ or 1 unit. Prerequisite: Economics 103 or 108. NOURSE.

366. **Mathematical Analysis in Economics.** This course is designed to acquaint the student with the application of mathematical techniques to economic theory, especially general equilibrium theory. ½ or 1 unit. Prerequisite: Economics 103 or 108; some knowledge of calculus.

371. **Sampling Theory and Technique.** Design of samples useful in economic and business research. Problems considered relate to the efficiency of sample designs, cost limitations, bias, non-sampling errors, and interpretation of results. Sampling theory is applied to specific sampling problems through the use of electronic computers. ½ or 1 unit. Prerequisite: Economics 173 or equivalent.

374. **Operations Research.** Introduction to methods of operations research from an executive or managerial viewpoint, emphasizing formulation of business problems in quantitative terms. Industrial applications of linear programming and dynamic programming, game theory, probability theory, queueing theory, and inventory theory. ½ or 1 unit. Prerequisite: Economics 173 and Industrial Administration 210, or consent of instructor.

384. **Economics of Transporation.** Economic aspects of the transportation industry with special emphasis on problems of regulation and public policy. ½ or 1 unit. Prerequisite: Economics 103 or 108. HARBESON.

386. **Current Transportation Problems.** An analytical and critical study of selected problems of current interest in transporation. ½ or 1 unit. Prerequisite: Economics 384. HARBESON.

389. **Industrial Competition and Monopoly.** The organization and tactics of market control, the development of antitrust law and policy, public policy regarding competitive practices, special policies applying to natural resource industries.

and regulated monopoly and government ownership as alternatives to the anti-trust approach. ½ or 1 unit. Prerequisite: Economics 103 or 108. HARBESON.

EDUCATION

(Including Educational Administration and Supervision, Educational Psychology, Elementary Education, History and Philosophy of Education, Secondary and Continuing Education, Special Education, and Vocational and Technical Education)

The graduate student who majors in education may specialize in administration and supervision, agricultural education, curriculum, education of exceptional children, educational psychology (including a special program in psychology of classroom learning and instruction), elementary school teaching, early childhood education, teaching of reading, guidance and counseling (including rehabilitation counseling), history and philosophy of education (including comparative education and social foundations of education), measurement and evaluation, research methods, school psychology, or any of the fields of secondary school education: English, home economics, industrial education, mathematics, modern languages, physical education, science, and social science.

Admission to graduate and professional degree work in education requires a grade-point average of 3.5 or higher and undergraduate preparation appropriate to advanced study in the chosen major. Applications who hold bachelor's degrees in fields other than teacher education are considered on an individual basis. See admission requirements for the Master of Education.

Master of Arts or Master of Science in Education. In addition to the general rules of the Graduate College (see pages 45 and 46), the following regulations apply to programs leading to the Master of Arts or Master of Science in Education:

(1) A minimum of eight units, including a thesis of not more than two units is required.

(2) Extramural course work is not applicable toward these degrees.

(3) Competence in certain fields is required, and may be demonstrated either by satisfactory grades in required courses or by satisfactory completion of proficiency examinations on those courses. History and Philosophy of Education 304 and 305, and Educational Psychology 311 and 312 are required.

Doctor of Philosophy. The general requirements of the Graduate College pertaining to the Doctor of Philosophy must be met. (See pages 46 to 48.) To become a candidate for the Doctor of Philosophy with a major in education, the applicant must hold a master's degree with a major in education or some appropriately related subject. An applicant who has not written a master's thesis will be required to prepare and submit a paper equivalent to a master's thesis. The applicant should present credentials well in advance of his first registration. Required examinations and other steps preliminary to admission must be completed prior to the registration period. Admission is not complete until the student has been accepted by an adviser.

PROFESSIONAL DEGREES

These degrees are designed for teachers, supervisors, administrative officers, and others engaged in educational work demanding broad, fundamental, and practical preparation and the ability to utilize professionally the contributions of research and philosophy.

Master of Education.

Admission. In addition to general requirements, the credit presented for admission must include sixteen semester hours in education with a grade-point average of 3.5 for all education courses.

Applicants holding bachelor's degrees in fields other than teacher education may be considered individually for admission to the program leading to the Master of Education. Applications admitted with deficiencies in professional education or for

teacher certification will be required to take a limited number of undergraduate courses. Such courses will not be counted in the eight units of graduate work required for the Master of Education.

In general, the professional education requirements for the Master of Education and for teacher certification may be fulfilled through proficiency examination in Educational Psychology 211, an appropriate methods course at the undergraduate level, student teaching, History and Philosophy of Education 304 and 305, and Educational Psychology 311 and 312. However, an applicant admitted with deficiencies should expect to take additional courses in the teaching subject fields.

Those preparing for teaching at the secondary level must have completed a minimum of thirty-two semester hours of appropriate course work in the first teaching field, if elected, and from twenty to twenty-four semester hours of credit in a second teaching field. Previous course work in such fields will be evaluated and considered in determining the eligibility of a student for teacher certification.

Graduate students admitted with deficiencies for teaching in the elementary schools will be required to complete Illinois teacher certification requirements through appropriate undergraduate and graduate course work.

The advisers of students admitted with deficiencies will develop programs in which a maximum number of teacher certification requirements are met through courses also acceptable in fulfillment of master's degree requirements. Students admitted with no deficiencies can complete requirements for the Master of Education through full-time study in two semesters. However, students admitted with deficiencies for certification should anticipate from one to two additional semesters of course work.

Program. At least eight units of course work, including four units in education, are required. History and Philosophy of Education 304 and 305 and Educational Psychology 311 and 312 are required, except from students who pass proficiency examinations in these courses.

There may be one or two minors. In general, candidates for the Master of Education are expected to take at least two units in fields other than education, particularly if the specialization is in secondary education. One unit at the 300 level in the teaching subject or subjects may be substituted for one of the three units at the 400 level otherwise required. Courses at the 200 level in the teaching subject or subjects may be taken for graduate credit subject to the prior approval of the Dean of the Graduate College, but total credit in such courses may not exceed two units. Credit earned in such courses can not be applied to the requirements for the Master of Arts, Master of Science, Doctor of Education, or Doctor of Philosophy.

Residence. At least four units must be earned while the student is in residence on the Urbana campus. The residence requirement may be met by spending two eight-week summer sessions as a full-time student. Students whose employment does not allow eight weeks of summer session attendance may earn one unit while in residence for four weeks and may satisfy the residence requirement in four summer sessions of four weeks each.

Advanced Certificate in Education.

Admission. A master's degree from an accredited institution, plus a minimum of two years' successful professional employment in education are required.

Program. A year of specialized professional study is required. Of the eight units of course work required, at least four must be in courses at the 400 level. Students who have not previously taken History and Philosophy of Education 304 and 305 and Educational Psychology 311 and 312, or equivalents, must take them or pass proficiency examinations. Course work may be taken in minor subjects under regulations similar to those stated above for the Master of Education. The program must be approved by the adviser and submitted in writing to the College of Education office before the student's first registration is completed.

Credit earned by a candidate for the Advanced Certificate is not accepted as meeting requirements for the Doctor of Education or the Doctor of Philosophy.

Residence. The residence requirement is similar to that for the Master of Education.

Doctor of Education. Programs leading to the Doctor of Education are designed to provide advanced professional training and develop further ability in the scholarly study of professional problems.

Admission. A candidate for admission must hold a master's degree from an accredited institution. Applications for admission should present credentials well in advance of the date for their first registration. Admission is determined by examination, personal interviews, record of previous education and experience, and recommendation from persons who have known the candidate.

A student may transfer from the Doctor of Education program to the program for the Advanced Certificate in Education prior to the completion of five units.

Program. Sixteen units of course work beyond the master's degree are required. Extramural course work may not be included in this sixteen-unit requirement. (Exceptions may be made for Educational Psychology 413 and Educational Administration and Supervision 461, 462, and 463.) A student who has completed course work beyond the master's degree at the University of Illinois or at another accredited institution may petition for the application of not more than six units of such work toward the program leading to the Doctor of Education. A student may, with the approval of his adviser, plan a maximum of four units of work to be accomplished at other accredited institutions. A minimum of ten units must be earned in courses taken at Urbana.

History and Philosophy of Education 410 and Educational Psychology 415 and 496 are required (note prerequisites).

A preliminary examination must be passed prior to beginning the dissertation. A student must complete at least eight units of course work subsequent to his admission and must pass a comprehensive written examination before he may enter the oral preliminary examination.

Prior to admission to the preliminary examination, the student is expected to demonstrate competence in the psychology of learning, psychology of adolescence or child growth and development, psychology of adjustment or mental hygiene and the school, social psychology, social foundations of education, philosophy of education, history of American education, and comparative education. Competence may be demonstrated by satisfactory grades or by satisfactory completion of proficiency examinations.

The thesis required for the Doctor of Education may be in the area of improving professional practice and may be a field study. No academic credit is granted for the thesis. General regulations of the Graduate College covering the examinations, filing of thesis titles, and the preparations, submission, and publication of theses must be met.

Residence. Minimum residence requirements are (1) two consecutive semesters, at least three units each, or (2) one semester, at least three units, and the summer session immediately preceding or following, at least one and one-half units, plus an additional summer session, at least one and one-half units.

Doctor of Education in Art Education. Doctor of Education candidates whose major field of study is art education follow programs for which the College of Education and the Department of Art share responsibility. Each student works under the joint direction of two faculty advisers, one from the College of Education and one from the Department of Art. For further information, see page 85.

Doctor of Education in Music Education. Doctor of Education candidates who major field of study is music education follow programs of study for which the College of Education and the School of Music share responsibility. Each student works under the joint direction of two faculty advisers, one from the College of Education and one from the School of Music. For further information, see page 299.

SCHOOL PSYCHOLOGY

Students who seek specialized preparation for work as school psychologists may become candidates for either the Doctor of Education or the Doctor of Philosophy. Doctor of Philosophy candidates may major in either education or psychology, though

every student who is preparing to become a school psychologist must include in his program of study extensive work in both education and psychology. The program of study for school psychologists requires a minimum of three years of graduate study plus twelve months as an intern. After an applicant is admitted as a graduate student in the department of his choice, his acceptance and his work in this program are subject to review by the Joint Committee on School Psychology, representing the College of Education and the Department of Psychology.

SPECIAL EDUCATION

Graduate study in special education is available at the master's degree, advanced certificate, or doctoral levels. Master's degree programs require one to two years and are designed primarily to prepare teachers of the culturally deprived, deaf, emotionally disturbed, gifted, mentally retarded, and children with learning disabilities. The Advanced Certificate requires at least a year of study beyond the master's degree and emphasizes preparation for supervision and administration of programs of special education. Doctoral programs require three or more years of advanced graduate study and are designed to prepare administrators, college instructors, and researchers in the various fields of special education indicated above. Special admission requirements apply to all graduate programs in special education. Further information concerning programs, admission requirements, and financial assistance may be obtained from the Chairman of the Graduate Selection Committee, Department of Special Education, 210 Education Building.

CLASSROOM LEARNING AND INSTRUCTION

Students planning to specialize in research and/or collegiate instruction in the educational psychology of classroom learning and instruction may become candidates for either the Doctor of Philosophy or the Doctor of Education. Doctor of Philosophy candidates major in education and minor in psychology or take a split minor with psychology and a related area, such as communications, or a subject such as mathematics, chemistry, or social studies. The program of study for the doctorate degree requires a minimum of three years of graduate study, including six months of internship. After an applicant is admitted, his study program is subject to review by one of the advisers associated with the program. A required core program consists of Educational Psychology 412, 449, 490, 492, 496, 497, and Psychology 418 and an internship of six months' minimum duration. The doctoral dissertation is generally written in the area of the nature, conditions, and improvement of classroom learning and instruction.

REHABILITATION COUNSELING

Students pursuing the Master of Education degree who plan to specialize in counseling and guidance normally require two academic years to complete this program, the fourth semester being devoted to supervised practice in an agency or institution located away from the campus. Doctoral programs also may be arranged to emphasize the study of rehabilitation counseling. Further information may be obtained from the Division of Counseling and Guidance, College of Education.

GRADUATE FACULTY

Professors: R. N. Evans (Dean of the College of Education), C. M. Allen, E. W. Anderson, J. M. Atkin, F. P. Barnes, M. Beberman, G. M. Blair, H. S. Broudy, J. R. Burnett, R. W. Burnett, J. J. DeBoer, J. A. Easley, Jr., B. Farber, F. H. Finch, J. G. Froehlich, J. J. Gallagher, N. E. Gronlund, J. T. Hastings, P. E. Hemp, K. B. Henderson, R. A. Henderson, W. P. Hurder, D. M. Jackson,

R. S. Jones, M. R. Karnes, Merle B. Karnes, W. V. Kaulfers, G. C. Kettelkamp, Colleen J. Kirk, S. A. Kirk, C. G. Knapp, K. M. Lansing, Celia B. Lavatelli, T. Manolakes, W. F. Marquardt, L. E. McCleary, J. E. McGill, C. J. McIntyre, W. P. McLure, L. E. Metcalf, P. V. Miller, W. J. Moore, T. E. Newland, M. M. Ohlsen, C. H. Patterson, L. J. Phipps, R. E. Pingry, S. P. Quigley, F. M. Raubinger, S. Rosen, C. W. Sanford, H. A. Schultz, J. H. Shores, Elizabeth Simpson, R. H. Simpson, J. M. Slater, B. O. Smith, R. E. Spencer, R. E. Stake, W. O. Stanley, L. M. Stolurow, M. R. Sumption, M. Tatsuoka, L. R. Tucker.

Associate Professors: R. C. Anderson, P. Braunfeld, A. L. Brophy, R. J. Colwell, C. B. Cox, D. C. Epperson, E. L. Evertts, L. A. Fisher, O. E. Gould, Laura J. Jordan, H. Kaczkowski, H. H. Lerch, M. L. Maehr, Mary Mather, F. McMurray, W. R. Powell, W. L. Shoemaker, P. B. Shoresman, R. A. Smith, Hazel T. Spitze, B. Spodek, R. A. Tinkham, R. M. Tomlinson, D. B. Tyack, J. L. Walker, J. R. Warmbrod.

Assistant Professors: L. Aleamoni, E. F. Anderson, T. H. Boardman, B. W. Carss, F. D. Carver, D. J. Delaney, N. R. Dodl, Jo Ann Fley, G. R. Fuller, G. V. Glass, E. K. Leslie, R. B. Lorenz, H. A. Moses, M. J. Phillips, W. M. Rogge, H. G. Rowe, T. J. Sergiovanni, O. L. Springer, K. J. Travers, R. W. Walker, C. K. West, M. S. Wolfe, J. L. Wolff, J. S. Zaccaria.

Educational Administration and Supervision

COURSES FOR GRADUATES

430. Elementary School Organization and Administration. Principal focus of this course is given to conceptual analyses of administrative and supervisory functions of the elementary school. Examination is made of administrative roles in the design, implementation, and improvement of the total educational program. Intensive use is made of research skills and strategies in the investigation of problems of instruction. In summer sessions this course is restricted to those without experience in administration and must be taken with Educational Administration and Supervision 464. Intended primarily for candidates for the master's degree. 1 unit. Prerequisite: Consent of instructor. Springer.

438. Instructional Supervision. Methods, theories, and research applying to supervision at all levels of public education. Analyses are made concerning the work of curriculum directors, general supervisors, special supervisors, supervising principals, and department heads. Study of supervisory methods, current plans for staff utilization, use of instructional materials, evaluation of educational programs, and evaluation of the effects of supervision are stressed. 1 unit. Prerequisite: Elementary Education or Secondary and Continuing Education 439; Educational Administration and Supervision 460. Sergiovanni, Springer.

440. Administration and Supervision of Junior and Senior High Schools. Principal focus of this course is given to conceptual analyses of administrative and supervisory functions of the secondary schools. Problems are then projected through case studies and situational descriptions as a means of examining tasks and processes in such areas as curriculum and instruction, pupil and staff personnel, student activities, school organization, and management and school-community relationships. In summer sessions this course is restricted to those without experience in administration and must be taken with Educational Administration and Supervision 464. Intended primarily for candidates for the master's degree.

1 unit. Prerequisite: Educational Administration and Supervision 460 or consent of instructor. CARVER, MCCLEARY, RAUBINGER, ROWE.

449. Independent Study. To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by consent of the dean. STAFF.

460. Public Control and Administration of Education. A course to provide the basic common understanding of theory and practice in operation and control of schools useful to teachers and other citizens. The course serves as an introductory course for prospective administrative officers and supervisors. Not open to experienced administrators nor to students who have taken any of the following courses (or equivalents): Educational Administration and Supervision 430, 440, 461, 462, 464, 465, 466. 1 unit. CARVER, MILLER, RAUBINGER, ROWE, SPRINGER.

461. Administration of Educational Programs and Personnel. Study of principles and criteria for analysis of programs at various levels of operation, such as instructional departments and pupil personnel service units, individual schools, local school systems, intermediate units, state education departments, and the federal government. Similar study is given to analysis of personnel requirements at various levels of operation. Educational Administration and Supervision 461, 462, and 463 constitute the required core program for all students specializing in educational administration who are candidates for a degree beyond the master's. 1 unit. Prerequisite: Educational Administration and Supervision 460 and 430 or 440. MCCLEARY, MILLER, ROWE, SERGIOVANNI.

462. Organization and Business Administration of Public Education. Organization and operation of public school government; functions and processes of school business administration, including internal organization of the division of business services; scope and role of the business manager, budgetary processes, accounting and financial reporting, contracts, liability, insurance, purchasing, auxiliary services, salary policies, and methods of survey, evaluation, and planning. 1 unit. Prerequisite: Educational Administration and Supervision 460, 430 or 440, and 461. MCLURE, RAUBINGER, WILSEY.

463. The Role of Administrative Leadership. Study of principles underlying administrative leadership drawn from such disciplines as philosophy, psychology, sociology, and public administration. Application of these principles in the analysis and formulation of general procedures by which the process of administration may be carried on most effectively to develop and operate efficient educational programs. 1 unit. Prerequisite: Educational Administration and Supervision 461, and Educational Psychology 413. MILLER, ROWE, SERGIOVANNI.

464. Field Problems in Educational Administration. Designed to give direct experience in the study of educational problems of concern to administrators. Each student selects and pursues one or more problems of study under the supervision of a professor. 1 unit. Prerequisite: Consent of instructor. STAFF.

465. Personnel Administration. Principles, problems, and trends in the administration of professional public school personnel: organization of personnel; assessment and definition of personnel needs; recruitment, selection, and induction; evaluation; personnel development programs; and teacher organizations. 1 unit. Prerequisite: Educational Administration and Supervision 460, 430 or 440, and 461. SERGIOVANNI, WILSEY.

466. Public School Finance. Advanced graduate study of the theory and technology of public school finance. Attention is centered on analysis of principles and theory underlying fiscal practice in various states; technical knowledge of designing

controls, organization, and fiscal systems in harmony with expressed theory; and the application of research to the analysis of problems related to the improvement of financing public schools. 1 unit. Prerequisite: Educational Administration and Supervision 462 or consent of instructor. McLure.

468. **School-Community Relations.** Study of the relationship of the American school to the community. Analysis of the power structure, social agencies, school liaison groups, and economic character of the community as they affect and are affected by the school. Includes an evaluation of the various media of communication between the school and the larger community, and the development of criteria for an effective program of school-community relations. 1 unit. Raubinger, Sumption.

469. **Legal Basis of School Administration.** The legal rights, privileges, responsibilities, immunities, and authority of pupil, parents, teachers, administrators, and school board members in relation to the school. 1 unit. Sumption.

470. **Principles and Resources for School Plant Planning.** Study of principles for planning functional school buildings. Primary emphasis is placed on the planning process involved in meeting the building needs of the school district, including (1) analysis and projection of educational programs to be housed, (2) prediction of pupil enrollments, (3) site selection, (4) educational specifications of buildings, and (5) rehabilitation, remodeling, and modernization of existing buildings. 1 unit. Prerequisite: Educational Administration and Supervision 460. Wilsey.

490. **Seminar for Advanced Students of Education.** Seminar in educational administration and supervision open only to persons who have been admitted for doctoral study in educational administration and supervision. 1 to 2 units. Staff.

491. **Field Study and Thesis Seminar.** Usually required of candidates for the Doctor of Education. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to Ed.D. candidates. 1 to 2 units. Staff.

499. **Thesis Research.** Individual direction of research and thesis writing. 0 to 4 units. Staff.

Educational Psychology

COURSES FOR GRADUATES

411. **Psychology of Adolescence for Teachers.** The psychological significance of adolescence, its biological and social foundations, and its implications for education. 1 unit. Prerequisite: Educational Psychology 311 and 312. Blair, Jones, Zaccaria.

412. **Advanced Child Development for Students of Education.** A consideration of the nature of the child and his development during the preschool and elementary school years, with emphasis on development as a process of social learning; interpretation of the scientific literature as it concerns the educative process; discussion of methods of studying and evaluating the behavior of the child as an individual and in group situations. 1 unit. Prerequisite: Educational Psychology 311 and 312. Cohen, Jones, Quay, Wolff.

413. **Social Psychology and the Problems of Education.** A consideration of the concepts and methods of social psychology as they apply to the professional functions of teachers, administrators, and other persons engaged in education.

Opportunity to work upon field problems is provided. 1 unit. Prerequisite: Educational Psychology 311, 312, and 390. MAEHR, R. H. SIMPSON.

414. The Psychology of College Teaching. Designed particularly for graduate students minoring in education or preparing for college teaching. Psycho-educational problems in undergraduate and graduate teaching, with special emphasis upon individual differences, remedial procedures, principles of learning, the technology of teaching and learning, adjustment problems of college students, counseling and advisory services, test construction, analysis and use of test results and resource materials in this field. 1 unit. Prerequisite: A course in psychology; consent of instructor. MENGES, R. H. SIMPSON.

415. Psychological Theories Applied to Education. An advanced course in human behavior required of all candidates for the degree of Doctor of Education. Special attention is given to contemporary systems of psychology and their relationship to educational practice. 1 unit. Prerequisite: Educational Psychology 311 and 312; Educational Psychology 411 or 412; candidacy for Ed.D. or Ph.D. in Education. BLAIR, JONES.

422. Basic Principles of Counseling. Study of counseling processes that are especially applicable to the problems of normal individuals. Theories of education and personality which underlie counseling procedures are studied for the purpose of developing the student's ability to evaluate these procedures. 1 unit. Prerequisite: Educational Psychology 311 and 312. DELANEY, KACZKOWSKI, LONG, OHLSEN, SHOEMAKER, SLATER.

423. The Use of Tests in Guidance. Practice in interpreting test results in case studies; study of the implications on test choices and usage of the philosophic orientation of the counselor, the type of case, the case setting, and the case information available; discussion of the advantages and disadvantages of particular tests for given types of cases. 1 unit. Prerequisite: Educational Psychology 390, 392, and 422, or equivalents. HASTINGS, KACZKOWSKI, PATTERSON, PHILLIPS.

424. Supervised Practice in Counseling. Study of the individual client through the use of the tools of the counselor. Each student is expected to develop professional skills by working with clients. 2 units. Prerequisite: Master's degree in guidance; consent of faculty committee. STAFF.

425. Principles of Guidance. For teachers, administrators, student advisers, and others who are interested in basic guidance principles and in guidance methods useful to schools and to agencies dealing with out-of-school youth and adults. Considers the role of guidance specialists and the guidance functions of community agencies. Students who have taken Educational Psychology 325 are not given credit for Educational Psychology 425. 1 unit. STAFF.

427. Principles and Techniques of Group Guidance. A study of the principles of group guidance and their application. Includes a review of the historical development of group guidance and the study of pertinent research. Discussion and role playing have an important part in the work of the course. Case materials are utilized. 1 unit. Prerequisite: Educational Psychology 311, 312, 422, 423, and either 325 or 425; or consent of instructor. KACZKOWSKI, MASUCCI, OHLSEN.

428. The Analysis and Use of Occupational Information in Guidance Programs. Deals with the results of recent occupational research and with the use of these results by teachers and counselors. Attention is given to research techniques suitable for use in local occupational studies. 1 unit. Prerequisite: Educational Psychology 425 or an introductory course in counseling. KACZKOWSKI, MASUCCI, OHLSEN, SHOEMAKER, ZACCARIA.

429. Field Instruction in Counseling. Individual instruction designed to help the advanced student apply the basic principles of counseling. Each student is assigned to a counseling agency. 1 or 2 units. Prerequisite: Educational Psychology 422

and 424 (with consent of instructor, registration in Educational Psychology 424 may be concurrent). STAFF.

447. **Seminar in Rehabilitation Counseling.** Problems of rehabilitation, including problems associated with specific physical and mental disabilities. Critical examination of literature pertaining to rehabilitation, with emphasis on recent publications. May be repeated for a maximum of one unit. ½ unit. Prerequisite: Educational Psychology 326 and 422. MOSES, PATTERSON.

449. **Independent Study.** To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by consent of the dean. STAFF.

490. **Seminar for Advanced Students of Education.** Seminar in educational psychology open only to persons who have been admitted for doctoral study in educational psychology. 1 to 2 units. STAFF.

491. **Field Study and Thesis Seminar.** Usually required of candidates for the Doctor of Education. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to Ed.D. candidates. 1 to 2 units. STAFF.

492. **Psychology of Learning and Instruction.** Same as Psychology 492. An advanced course in the nature and conditions of long-term cognitive learning and retention in classroom and similar situations. This course is intended for doctoral students with a special interest in research leading to the improvement of classroom teaching and learning, in psychological aspects of curriculum research, and in the cognitive aspects of military and industrial training. 1 unit. Prerequisite: Consent of instructor: ANDERSON.

494. **Multivariate Analysis in Psychology and Education.** Same as Psychology and Sociology 494. The principal methods of descriptive statistics used in the analysis of multiple measurements, with emphasis on conventional procedures of factor analysis; profile similarity models; discriminatory analysis; multi-dimensional scaling. 1 unit. Prerequisite: Psychology 307 or Educational Psychology 496; consent of instructor. TUCKER, WARDROP.

495. **Theory of Measurement.** Same as Psychology 495. Logical and mathematical principles underlying test design, construction, and validation, with particular emphasis on evaluating reliability of measurement, utility resulting from test-based decisions, and validity of descriptions of individuals. 1 unit. Prerequisite: Educational Psychology 496 or Psychology 307 or equivalent; Educational Psychology 392 or Psychology 290, or equivalent. STAKE, TUCKER.

496. **Statistical Methods in Education.** First graduate course in statistical methods in education. Includes an introduction to the logic of scientific method in education; probability and sampling in education, correlation methods in educational measurements and research; partial and multiple correlation and the testing of statistical hypotheses; and other applications of statistics to educational research. 1 unit. Prerequisite: Educational Psychology 390. ALEAMONI, PINGRY, STAKE, TATSUOKA.

497. **Advanced Statistical Methods in Education.** An advanced course in statistical methods applied to educational research. Analysis of variance and co-variance, experimental design, introduction to multivariate statistical techniques including

discriminant analysis. 1 unit. Prerequisite: Educational Psychology 496. TATSUOKA.

498. **Theory of Educational Evaluation.** Study of relationship between educational purposes, curriculum, and evaluation through emphasis on principles of evaluation dealing with classifications of behavior. A detailed study of the concept of test validity, of its determination, and of its relation to test design, with emphasis on the evaluation of outcomes involving the higher mental processes. Guided practice in solving complex problems of evaluating behaviors, some in subject matter areas but primarily those cutting across subject matter lines. 1unit. Prerequisite: Educational Psychology 496. HASTINGS, SPENCER, STAKE.

499. **Thesis Research.** Individual direction of research and thesis writing. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. **Psychology of Learning for Teachers.** A consideration of learning situations in the light of psychological findings and concepts. Development of a theory of learning, and its application to the teaching of attitudes, skills, and understanding. ½ unit. Prerequisite: Educational Psychology 211; practice teaching or teaching experience. STAFF.

312. **Mental Hygiene and the School.** An examination of social and emotional adjustment. Study of normal personality, integration, feelings of inferiority, adjustment mechanisms, classroom therapy, behavior disorders in children, and introduction to methods of child study and provision for emotionally disturbed children. ½ unit. Prerequisite: Educational Psychology 211; practice teaching or teaching experience. STAFF.

313. **Programmed Instruction.** The design, production, and evaluation of self-instructional materials, including delineation of objectives, task analysis, frame writing, frame editing, pilot testing and revision, and field testing; survey of current research and orientations toward programed instruction; consideration of the mechanized and text forms for presenting programs. Each student prepares a self-instructional program. 1 unit. Prerequisite: Educational Psychology 311. ANDERSON.

325. **Introduction to Guidance and Counseling.** Basic concepts and practices of guidance in schools; what the teacher can do in guidance. Students may not register for credit in both Educational Psychology 325 and 425. ½ unit. Prerequisite: Eight semester hours in education and psychology. KACZKOWSKI, LONG.

326. **Introduction to Vocational Rehabilitation Counseling.** A survey of the history and development of vocational rehabilitation programs; contributions of related disciplines and their integration; basic procedures and problems of vocational rehabilitation counseling. ½ unit. Prerequisite: Consent of instructor. MOSES, PATTERSON.

339. **Corrective Reading.** Same as Elementary Education 339. Practice in administering and interpreting group diagnostic reading tests; instructional techniques appropriate for less severe reading disabilities. 1 unit. Prerequisite: Elementary Education 336 or 338. BENNETT.

343. **Individual Intelligence Testing.** The fundamental concepts relevant to the general problem of the individual testing of learning aptitude. Acquisition of psychometric competence in the use of the 1960 Binet and the Wechsler tests. Acquaintance and limited practice in the administration, scoring, and interpretation of results obtained by means of performance scales and other devices appropriate for use with individuals having sensory, associative, and/or motor

impairments. 1 unit. Prerequisite: Consent of instructor and six hours of psychology; Special Education 324 or Educational Psychology 392 or Psychology 390, or equivalent. NEWLAND, PHILLIPS.

360. **Educational Uses of Television and Radio.** Same as Communications and Radio-Television 360. A study of television and radio as educational instruments, and standards necessary for such use; production, utilization, planning, and evaluation; primary and secondary uses. Identification of the unique contributions and resources of the electronic media, as well as their limitations. Experimentation into new production and utilization techniques designed for educational uses. ½ unit. MCINTYRE, SKORNIA.

390. **Elements of Educational Statistics.** Designed for terminal value for professional training of students not intending to pursue advanced graudate work, and for introductory value for students continuing graduate study in education. The course includes descriptive statistics, introduction to correlation and regression, the normal curve, statistical inference, and the presentation and interpretation of statistical data in educational literature. 1 unit. Prerequisite: Educational Psychology 211 or 236. ALEAMONI, HASTINGS, PINGRY, STAKE, TATSUOKA.

391. **Construction and Use of Tests in Teaching.** Includes the relationship of classroom testing to educational objectives and the curriculum; the construction, administration, and scoring of the various types of essay and short-answer tests; and other means of measuring the attainment of objectives and marking procedure. Designed primarily for classroom teachers. 1 unit. Prerequisite: Educational Psychology 211 or 236. GRONLUND, HASTINGS, SPENCER.

392. **Introduction to the Principles of Measurement.** Study of the selection, preparation, administration, and interpretation of psychological and educational tests and diagnostic devices, with emphasis on theory at a beginning level and with application to hypothetical school situations as a teaching device. Sources of standard tests, criteria for their evaluation, methods of scoring, interpretation, and general and special areas are considered. 1 unit. Prerequisite: Educational Psychology 211 or Elementary Education 236. GRONLUND, HASTINGS, KACZKOWSKI, SPENCER, STAKE.

Elementary Education

COURSES FOR GRADUATES

431. **Elementary School Classroom Programs.** An exploration of organizational centers for determining selection and sequence of educative experiences in the elementary school classroom. The role of the teacher in curriculum construction is emphasized. 1 unit. STAFF.

432. **Clinical Diagnosis and Remediation in Reading.** Supervised experience in the Reading Center; special attention is given to evaluative and interpretative techniques in cases of severe reading disabilities based on the analysis of specific reading needs. May be repeated for a maximum of 2 units of credit. 1 unit. Prerequisite: Elementary Education 339 and a course in individual mental testing. POWELL.

433. **Curriculum Problems and Trends in Special Fields of Elementary Education.** A study of the place of the various special fields of elementary education in the emerging elementary school curriculum, with a review and analysis of recent trends and research findings in these fields. Sections are usually offered in the following fields: (a) language arts, (b) social studies, (c) arithmetic, (d) science, (e) creative arts, (f) reading, (g) early childhood education. 1 unit. Prerequisite: For all sections, Elementary Education 431 or 434; for the section in language

arts, Elementary Education 333 and 336, or a course in the teaching of reading or language arts, or consent of instructor; for the section in creative arts, Elementary Education 337 or consent of instructor; for the section in science, Elementary Education 335 or a methods course in teaching science in the elementary school and two years of college science, or consent of instructor; for the section in reading, Elementary Education 336 or a course in teaching of reading; for the section in early childhood education, Elementary Education 434. STAFF.

434. Programs in Early Childhood Education. An advanced course intended primarily for teachers and supervisors of younger children, ages three to eight. Presents a review and analysis of research findings, experimentation, and current trends in curriculum organization, procedures, and materials essential to developing classroom programs for children. 1 unit. KATZ, LAVATELLI, SPODEK.

435. Diagnosis and Correction in Elementary Mathematics. The nature, causes, and correction of mathematical difficulties at the elementary level; process of evaluation through group and individual procedures; the development and use of diagnostic instruments and corrective techniques; supervised experience with pupils having difficulties. 1 unit; may be repeated for a maximum of 2 units. Prerequisite: Elementary Education 332; Educational Psychology 392; or equivalent.

436. Field Instruction in Reading Programs. Provides for directed practice in the area of reading; students are placed in an approved and supervised field position for part of the semester. 1 unit. Prerequisite: Elementary Education 432. STAFF.

437. Methods of Child Study. A study of ways in which teachers can evaluate child behavior and development. Particular emphasis is placed on classroom application. Instruction and practice in the use and interpretation of observations, anecdote records, rating scales, interviews, achievement tests, intelligence tests, questionnaires, sociometric and projective techniques. 1 unit. Prerequisite: Educational Psychology 312 or consent of instructor. KATZ, LAVATELLI, SPODEK.

438. The Organization and Supervision of School Reading Programs. Study of procedures for planning, improving, and evaluating reading programs on a systemwide basis. Open only to those persons who are preparing to supervise reading programs or with approval of graduate adviser. 1 unit. Prerequisite: Elementary Education 339 or Educational Psychology 339; Elementary Education 433. STAFF.

439. Fundamentals of Curriculum Development. Designed to explore and clarify the several theoretical bases offered in educational literature for each of the major aspects of curriculum planning, to indicate the forms implementation of these theories have assumed in practice, to reduce these theoretical and practical differences to fundamental issues, to encourage critical evaluation of both the theories and practices from the standpoint of logical and empirical evidence, and to project, on the basis of such analysis, needed research, present best practice, and ultimately desirable programs. 1 unit. MCGILL, SHORES.

449. Independent Study. To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by special consent of the dean. STAFF.

455. Theories of Art Education. A study of the major theories of art education and an analysis of the most significant research in the field. Emphasis is given to a critical evaluation of theory and research and to the application of such studies to current problems in art education in the public schools. 1 unit. Prerequisite:

Elementary Education 337 or Secondary and Continuing Education 456, or consent of instructor. LANSING.

459. **Workshop in Curriculum Development.** Curriculum development projects in specialized fields of elementary education. 1 to 2 units. STAFF.

490. **Seminar for Advanced Students of Education.** Seminar in elementary education open only to persons who have been admitted for doctoral study in elementary education. 1 to 2 units. STAFF.

491. **Field Study and Thesis Seminar.** Usually required of candidates for the Doctor of Education. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentation. Limited to Ed.D. candidates. 1 to 2 units. STAFF.

499. **Thesis Research.** Individual direction of research and thesis writing. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

332. **Principles and Practices in Elementary Mathematics Education.** Organization, scope, and sequence of the elementary mathematics program and the functional nature of mathematics; methods, techniques, experiences, and materials of value in teaching elementary mathematics, and the role of the classroom teacher. ½ or 1 unit. Prerequisite: Mathematics 202 and 203 or equivalent.

333. **The Teaching of Language Arts in the Elementary School.** Concerns itself with goals, content, and teaching problems involved in the devising of programs in the area of elementary school language arts that are cumulative and sequential from kindergarten through the elementary school. ½ to 1 unit. Prerequisite: Educational Psychology 236. EVERTTS, MOORE.

334. **Principles and Practices in Early Childhood Education.** A study of the practices and principles of using play as an educational tool in early childhood education; presents a review of historical, philosophical, and psychological foundations of nursery-kindergarten methods, assesses techniques relating play to various aspects of instruction, surveys materials and equipment, and presents methods of classroom evaluation. ½ unit. Prerequisite: Elementary Education 237. KATZ, SPODEK.

335. **Science in the Elementary School.** The principles, place, and practice of science education in the elementary school and in the lives of children. The course stresses the functional nature of science and its place in the curriculum. Consideration is given to the organization of the science program, experiences, and techniques of value in teaching and of the role of the clasroom teacher and the specialist. Opportunity for experience in field and laboratory work. ½ unit. Prerequisite: Elementary Education 233 and 237, or equivalent; two years of college science. ATKIN, R. W. BURNETT, SHORESMAN.

336. **Primary Reading.** Basic principles, techniques, and materials for the developmental reading program in the primary grades. Emphasis is placed on methods and materials which provide for differentiated instruction. ½ or 1 unit. Prerequisite: Junior standing; registration in a teacher education curriculum. DURKIN, MOORE, POWELL, SHORES.

337. **Art Education in the Elementary School.** Methods, plans, and materials for teaching art as an integral part of the total educational program in the elementary school. ½ unit. Prerequisite: Junior standing. LANSING, SCHULTZ.

338. **Teaching of Reading in Grades Four Through Twelve.** Same as Secondary and Continuing Education 338. Developmental reading programs beyond the primary grades. Factors related to reading speed and comprehension: vocabulary development, specific comprehension skills, study skills, reading interests and tastes. ½ or 1 unit. Prerequisite: Elementary Education 336 or Educational Psychology 211. STAFF.

339. **Corrective Reading.** Same as Educational Psychology 339. Practice in administering and interpreting group diagnostic reading tests; instructional techniques appropriate for less severe reading disabilities. 1 unit. Prerequisite: Elementary Education 336 or 338. POWELL.

354. **Audio-Visual Communication.** See Secondary and Continuing Education. 1 unit.

History and Philosophy of Education

COURSES FOR GRADUATES

400. **Problems of Educational Theory.** Analysis of the kinds of problems encountered in constructing an educational theory, and of relations between educational theory and other disciplines, especially philosophy and the social sciences. 1 unit. Prerequisite: History and Philosophy of Education 301 or 305. MCMURRAY.

401. **Modern Theories of Education.** A critical analysis and examination of the theories of education represented by the work of Robert M. Hutchins, Henry C. Morrison, the Harvard Committee, and William H. Kilpatrick. 1 unit. STANLEY.

402. **Educational Movements in the Twentieth Century.** A historical study of significant educational trends during the past sixty years, with special reference to their influence on American education; an analytical examination of the principal transition movements in the last decade of the nineteenth century and of efforts to solve the problems since 1900. 1 unit. Prerequisite: Consent of instructor. TYACK.

403. **The Historical Foundations of American Educational Thought.** A study of the evolution of educational theories and philosophies since the eighteenth century, with particular reference to their impact upon educational developments in the United States. Effort is made to give a broad view of the general growth of American educational thought, with sufficient time devoted to selected major educational theorists, or schools of thought, to permit adequate exploration of their fundamental ideas and the relation of these ideas to significant intellectual currents in American culture. 1 unit. Prerequisite: Consent of instructor. TYACK.

404. **Seminar in Educational Classics.** Reading and group discussion of a limited number of the most important writings in educational philosophy which have had a profound influence on the progress of educational thought and practice. 1 unit. Prerequisite: One graduate course in philosophy of education and one in history of education, or consent of instructor. BROUDY.

405. **Foundations of Aesthetic Education.** A philosophical approach to the problems of teaching for appreciation in formal education. Appraisal of the status of aesthetic education, its nature and function, and its relation to other types of education are the major areas investigated. 1 unit. Prerequisite: Consent of instructor. BROUDY.

406. **Seminar in the History of Education.** Intensive group study of a small number of selected problems to assist individual students to develop an understanding of and the ability to use the techniques of historical research in furthering such

study. Problems studied in any one semester are selected in the light of the interests and previous training of the group of students enrolled. 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Two courses in the history of education and one course in the philosophy of education, or consent of instructor. TYACK.

407. **Logical Foundations of Methods.** A study of the application of principles of logic in methods of instruction. This study involves the treatment of the problems of educational direction and control in processes of inference, judgment and knowing, examined from the standpoint of recent developments in pragmatism. 1 unit. Prerequisite: Consent of instructor. MCMURRAY.

408. **Advanced Philosophy of Education.** A systematic exploration of knowledge and inquiry as they relate to problems of formulating educational policy, curriculum design, organization of the school system, and teaching-learning. Selected materials in the history of epistemology are examined and emphasis is placed on a critical appraisal of significant trends in educational theory: 1 unit. Prerequisite: History and Philosophy of Education 301 or 305 or advanced graduate standing; consent of instructor. BROUDY, J. R. BURNETT, STANLEY.

409. **Advanced Philosophy of Education.** A study of the nature of value as it relates to problems of formulating and justifying educational aims and policies, curriculum design, organization of the school system, and teaching-learning. Selected materials in ethics, value theory, and aesthetics are used in the critical appraisal of significant trends in educational theory. 1 unit. Prerequisite: History and Philosophy of Education 301 or 305 or advanced graduate standing; consent of instructor. BROUDY, J. R. BURNETT, STANLEY.

410. **Seminar in Theories of Educational and Social Change.** Designed to help prospective educational leaders acquire an understanding of current theories of social change as these relate to the work of the profession of teaching. There is now an extensive body of knowledge on the nature and control of social change. This needs to be made available to all prospective educational leaders in order that they may go about their duties with greater understanding and skill. Designed to aid students in bringing this knowledge to bear upon the problems of leadership in educational and social change. 1 unit. Prerequisite: Candidacy for Ed.D. or Ph.D. in education. BROUDY, J. R. BURNETT, FEINBERG, B. O. SMITH, STANLEY.

449. **Independent Study.** To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by consent of the dean. STAFF.

483. **Methods in Comparative Education.** Methodologies and concepts involved in comparative educational systems in selected countries; topics related to the role of normative, institutional, and environmental patterns in shaping educational policies related to administration, curriculum development, diversification and expansion of educational opportunity. 1 unit. Prerequisite: Anthropology 373, Sociology 300, History and Philosophy of Education 303, or consent of instructor. PESHKIN, YATES.

490. **Seminar for Advanced Students of Education.** Seminar in history and philosophy of education open only to persons who have been admitted for doctoral study in history and philosophy of education. Sections are usually offered in the following fields: (a) history of education, (b) philosophy of education, (c) comparative education, (d) social foundations of education. 1 to 2 units. Prerequisite: For

section (c) only, History and Philosophy of Education 483 or consent of instructor. STAFF.

491. Field Study and Thesis Seminar. Usually required of candidates for the Doctor of Education. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to Ed.D. candidates. 1 to 2 units. STAFF.

499. Thesis Research. Individual direction of research and thesis writing. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. The History of Education. Brief introductory survey of ancient and medieval education followed by a more extended study of educational developments since the Italian Renaissance. Special emphasis on the relation of educational trends to broader social, economic, political, and intellectual movements. ½ unit. TYACK.

301. Philosophy of Education. Based on Dewey's *Democracy and Education*, this course is an examination of experimentalist philosophy in its bearings on educational problems; nature and aims of education in a democratic society; relation of the individual to society; interest and discipline; play and work; freedom and control; subject matter and method. ½ unit. J. R. BURNETT, MCMURRAY, STANLEY.

302. History of American Education. The development of American education in relation to political, social, and cultural developments. Special attention is given to the influence of movements in the cultural environment upon evolving conceptions of educational theory and practice. ½ unit. TYACK.

303. Comparative Education. A study of selected national systems of education in their differing cultural settings. ½ unit. PESHKIN, YATES.

304. Social Foundations of Education. An introductory survey of the interrelationship between school and society and of the impact on public education of the major social trends and forces operating in our society. ½ unit. J. R. BURNETT, DIEKMA, FEINBERG, B. O. SMITH, STANLEY.

305. History of Educational Ideas. Through a study of selected educational theorists and intellectual movements, this course provides familiarity with the major educational ideas of the past, as well as historical perspectives on current issues and problems in education. Readings in Plato, Quintilian, St. Augustine, Loyola, Comenius, Rousseau, Pestalozzi, Froebel, Herbart, Dewey, and others. ½ unit. FEINBERG, MCMURRAY, TYACK.

315. Sociology of Education. Same as Sociology 315. Objective comparative study of education as a social process in various cultures and historical periods, with main emphasis on present education in countries which share Western civilization. ½ or 1 unit. Prerequisite: Sociology 100, or 104 and 105, or Division of General Studies 151 and 152.

385. The Anthropology of Education. Same as Anthropology 385. Introduction to the contribution of anthropology to the cross-cultural study of education; includes illustrative material from representative cultures ranging from primitive social groups to present-day national states; emphasis is on education as a cultural process in relation to culture change and cultural development. ½ to 1 unit. Prerequisite: A course in anthropology or sociology or consent of instructor.

Secondary and Continuing Education

COURSES FOR GRADUATES

439. Fundamentals of Curriculum Development. Designed to explore and clarify the several theoretical bases offered in educational literature for each of the major aspects of curriculum planning, to indicate the forms implementation of these theories have assumed in practice, to reduce these theoretical and practical differences to fundamental issues, to encourage critical evaluation of both the theories and practices from the standpoint of logical and empirical evidence, and to project, on the basis of such analysis, needed research, present best practice, and ultimately desirable programs. 1 unit. DeBoer.

441. Linguistic and Logical Analysis of Teaching. An analysis of teaching from the standpoint of semantic and logical factors. Topics such as theories of meaning, definition, explanation, and justification as employed by a teacher are discussed. 1 unit. K. B. Henderson.

448. Continuing Education. Development, status, and prospects of continuing education for adults. Institutions, agencies, and programs; public policy and policy-making for continuing education; organization, administration, finance, and promotion; recruiting, training, and supervising staff; planning programs and courses; the literature of continuing education. Systematic study of individual problems supplements class work. ½ or 1 unit. Phipps.

449. Independent Study. To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by consent of the dean. Staff.

456. Problems and Trends in Specialized Fields of Secondary Education. This course introduces the student to significant problems, points of view, and trends in the field concerned. Significant research relating to organization, content, and techniques in the field in question is explored. Students are encouraged to make special studies in approved areas. 1 unit. Sections are usually offered in the following fields:

(a) English. DeBoer, Erickson, Madsen, Marquardt, Walker.
(b) Foreign Languages. Daigh, Kaulfers, Kettelkamp.
(c) Mathematics. K. B. Henderson, Pingry, Travers.
(d) Science. R. W. Burnett, Gould, Weller.
(e) Social Science. Cox, Metcalf.
(f) Physical Education. Knapp.
(g) Music. Colwell.

459. Workshop in Curriculum Development. Curriculum development projects in specialized fields of secondary and continuing education. 1 to 2 units. Staff.

467. The American College. Development of the American college and university; higher education processes, organization, and administration; the variety of problems and conflicting theories; policies, practices, and present trends. 1 unit. Epperson, Fley.

490. Seminar for Advanced Students of Education. Seminar in secondary and continuing education open only to persons who have been admitted for doctoral study in secondary and continuing education. 1 to 2 units. Metcalf.

491. Field Study and Thesis Seminar. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception,

delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to Ed.D. candidates. 1 to 2 units. STAFF.

499. Thesis Research. Individual direction of research and thesis writing. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

338. Teaching of Reading in Grades Four Through Twelve. Same as Elementary Education 338. Developmental reading programs beyond the primary grades. Factors related to reading speed and comprehension; vocabulary development, specific comprehension skills, study skills, reading interests and tastes. ½ or 1 unit. Prerequisite: Elementary Education 336 or Educational Psychology 211. ERICKSON.

354. Audio-Visual Communication. Same as Elementary Education 354. An analysis and application of those introductory aspects of communication theory and practices concerned with the design and use of audio-visual messages which influence the learning process. This course is also concerned with selection, utilization, production, and evaluation of audio-visual materials and selected technological aids. ½ or 1 unit. LORENZ.

Special Education

COURSES FOR GRADUATES

416. Problems in Mental Deficiency. An advanced course in mental deficiency, covering definitions, theories, classifications, etiology, diagnosis, and social, medical, psychological, and educational rehabilitation procedures. Emphasis is on the contributions of biology, sociology, anthropology, and psychology to educational theory and practice with reference to the mentally deficient. 1 unit. Prerequisite: Special Education 322 or consent of instructor. R. A. HENDERSON, S. A. KIRK.

417. Psycho-Educational Problems of Exceptional Children. A course for educators, students in the behavioral sciences, and students beginning graduate study in special education. Study of relevant research dealing with the physical, mental, emotional, and social traits of all types of exceptional children and consideration of major current problems in the development of educational programs. 1 unit. Prerequisite: Sixteen hours of psychology and/or education or consent of instructor. DURANT, R. A. HENDERSON, QUIGLEY.

418. Communicative Problems of the Deaf. An advanced course in the problems and procedures involved in the acquisition of language and communication by persons with severe hearing impairment, particularly those with profound prelingual deafness. Emphasis is placed on research and measurement in the development of speech, speechreading, residual hearing, reading, written language, and manual communication, including finger spelling and the language of signs. The applications of recent approaches in linguistics and psycholinguistics to language development are stressed. 1 unit. Prerequisite: Consent of instructor. QUIGLEY.

419. Diagnosis of Learning Disabilities. A course covering the advanced theory and technology of learning disabilities with special reference to etiology and diagnosis. The main emphasis is on the psychoneurological, genetic, and psycholinguistic aspects of reading disorders. Remediation which is implicit in diagnostic procedure is also covered. Laboratory practice is required. This is the first half of a year's sequence with Special Education 444. 1 unit. Prerequisite: Special Education

318 (b); Psychology 443 or Educational Psychology 343; consent of instructor. BANNATYNE.

420. **The Social Psychology of the Handicapped.** A study of the social and emotional adjustment of handicapped children and adults, and of the somato-psychological significance of mental, sensory, and motor variations in the adjustive process. The effects of limitations imposed by the attitude of society, the attitude of the individual toward his handicap, and the handicap itself are evaluated. Implications for current educational programs for the handicapped are analyzed. 1 unit. Prerequisite: Special Education 117 or 417 and Educational Psychology 312, or consent of instructor. FARBER, GALLAGHER, NEWLAND.

421. **Administration and Supervision of Special Education.** Designed for advanced graduate students preparing for administrative or supervisory positions in special education programs. Administrative and supervisory practices in educating exceptional children are examined with emphasis on special education programs in the public schools; application of administrative theory to special education programs. Field trips to observe and evaluate programs are required. 1 unit. Prerequisite: Special Education 417; Educational Administration and Supervision 460; consent of instructor. CHALFANT, R. A. HENDERSON, M. B. KARNES.

444. **Remediation of Learning Disabilities.** The course covers the theory and practice of remediation of children with learning disabilities, with emphasis on matching a wide variety of methods to specific deficits. Advanced diagnostic procedures and teaching, prescription writing, and evaluative monitoring are covered. The course includes supervised clinical practice. 1 unit. Prerequisite: Special Education 318 (b) and 419. BANNATYNE.

449. **Independent Study.** To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by consent of the dean. STAFF.

456. **Problems and Trends in Special Education.** Introduces the student to significant problems, points of view, and trends in the field concerned. Significant research related to organization, content, and techniques in the field in question is explored. Students are encouraged to make special studies in approved areas. Sections may be offered in the following fields: (a) mental retardation, (b) learning disabilities, (c) gifted children, (d) deaf children, (e) emotionally disturbed children, (f) programmed learning for exceptional children, and (g) culturally disadvantaged children. 1 to 2 units. Prerequisite: Consent of instructor. STAFF.

459. **Workshop in Curriculum Development.** Curriculum development projects in specialized fields of special education. 1 to 2 units. STAFF.

490. **Seminar for Advanced Students of Education.** Seminar in the education of exceptional children open only to persons who have been admitted for doctoral study. 1 to 2 units. STAFF.

491. **Field Study and Thesis Seminar.** Usually required of candidates for the Doctor of Education. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to Ed.D. candidates. 1 to 2 units. STAFF.

499. **Thesis Research.** Individual direction of research and thesis writing. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

316. The Gifted Child in School and Society. A consideration of the gifted in society: who they are, their physical, psychological, social, and educational characteristics, and society's needs and provisions for them. The major portion of the course is devoted to the consideration and evaluation of instructional and administrative adjustments that should be made for the gifted in the educational structure. ½ to 1 unit. Prerequisite: Educational Psychology 211 or 236; consent of instructor. DURANT, GALLAGHER, ROGGE.

317. Psycho-Social Educational Aspects of Deafness. Historical and current societal preceptions of the deaf; analysis of the various effects and patterns of auditory impairment on children and adults; intelligence, personal and social adjustment, the psychological processes, and how they affect the acquisition of language, speech, speechreading, reading, and writing. ½ to 1 unit. Prerequisite: Special Education 117 and Psychology 100 or Educational Psychology 211. QUIGLEY.

318. Workshop and Laboratory in Education of Exceptional Children. For those specializing in exceptional children. The following sections may be offered: (a) mental retardation, (b) learning disabilities, (c) gifted children, (d) deaf children, (e) emotionally disturbed children, (f) programmed learning for exceptional children, (g) culturally disadvantaged. 1 to 2 units. Prerequisite: Consent of instructor. STAFF.

319. Special Education of the Deaf, I. Survey of the curriculum and techniques in preschools, kindergarten, primary, and intermediate levels as applied to the hard-of-hearing, deafened, and deaf child; study of sense training, lip reading, vocabulary development, reading techniques, elementary school subjects, language and speech development, auditory training, and curriculum construction. 1 to 1½ units. Prerequisite, Consent of instructor. SCHMITT.

320. Special Education of the Deaf, II. Continuation of Special Education 319. 1 to 2 units. Prerequisite: Special Education 319. SCHMITT.

321. Education of Disturbed and Conduct-Problem Children. A study of the social, emotional, and learning characteristics of children who are disturbed or who exhibit problems of conduct; methods of diagnosis and differentiation; educational environments and teaching methods used for their remediation. ½ to 1 unit. Prerequisite: Special Education 117 or equivalent; Educational Psychology 236 or equivalent. GLAVIN.

322. Psychology and Education of the Mentally Handicapped, I. A study of the social, emotional, physical, and learning characteristics and problems of mentally handicapped children; identification and diagnosis; available services and provisions; educational programs and curriculum of the school. ½ unit. Prerequisite: Consent of instructor. CLARK, JORDAN.

323. Psychology and Education of the Mentally Handicapped, II. Continuation of Special Education 322, with emphasis on curriculum. ½ unit. Prerequisite: Special Education 322. CLARK, JORDAN.

324. Mental and Educational Measurement of Exceptional Children. Designed primarily to develop an understanding of and ability to interpret the results of psychological and educational tests. Practice is provided in test administration, with emphasis on diagnosis and problems encountered in testing children who are acoustically, orthopedically, visually, or mentally handicapped, or speech defective. ½ or 1 unit. Prerequisite: Special Education 117 or consent of instructor. STAFF.

Vocational and Technical Education

COURSES FOR GRADUATES

442. **Junior College.** The place of the junior college in the modern program of public education; social, economic, and other changes responsible for development of post-secondary education as found in junior colleges, area vocational schools, and technical institutes. 1 unit.

445. **Investment in Human Resources.** Same as Labor and Industrial Relations 445. Activities which influence future monetary and psychic income by improving the resources in people. The investments covered include schooling, on-the-job training, medical care, migration, and the search for information on prices and incomes, with main emphasis on education. A last section covers educational planning. 1 unit. Prerequisite: An introductory course in economics and in quantitative methods. STAFF.

449. **Independent Study.** To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by consent of the dean. STAFF.

450. **Evaluation in Home Economics Education.** Theory and techniques of evaluation in home economics at different educational levels; analysis and refinement of instruments, interpretation of results for self-evaluation and guidance, and effective administration of programs. 1 unit. MATHER, E. SIMPSON, SPITZE.

451. **Supervision in Home Economics Education.** The theory, principles, and techniques of pre-service and in-service training of teachers of home economics; organization, administration, evaluation, and possible future improvement of existing programs. Class visitation and other techniques practiced; supervisory materials prepared. 1 unit. MATHER.

453. **Problems in Home Economics Education.** Designed to prepare "consumers of research" through a comprehensive study and evaluation of home economics investigations now available and through the experience of carrying out an individual investigation of limited scope. 1 unit. E. SIMPSON.

456. **Problems and Trends in Specialized Fields of Vocational and Technical Education.** This course introduces the student to significant problems, points of view, and trends in the field concerned. Significant research relating to organization, content, and techniques in the field in question is explored. Students are encouraged to make special studies in approved areas. Sections are usually offered in the following fields: (a) agricultural education, (b) business education, (c) home economics education, (d) industrial education. 1 unit. STAFF.

459. **Workshop in Curriculum Development.** Curriculum development projects in the specialized fields of agriculture, business, home economics, and industry. ½ to 2 units. STAFF.

471. **Policy and Program Development for Education in Agriculture.** Local, state, and national policies for agricultural education; organizing for policy-making; developing desirable policies and programs. ½ unit. Prerequisite: Vocational and Technical Education 276 and 277. Open to school administrators and extension educators without prerequisite. PHIPPS.

472. **Course Planning and Teaching Procedures in Vocational Agriculture.** Gathering data essential in course planning, constructing course plans, developing resource units, teaching procedures, and instructional aids. ½ unit. Prerequisite:

Vocational and Technical Education 276 and 277, or consent of instructor. Fuller, Hemp.

473. **Vocational Education in Agriculture for Adults.** The case for adult education, needs of young and adult farmers for education, development and present status of adult education in agriculture, objectives, evaluation, using advisory committees, organizing adult classes, enrolling students, course planning, teaching procedures and aids, supervised practice, group activities, facilities. ½ unit. Prerequisite: Vocational and Technical Education 276 and 277, or consent of instructor. Hemp.

474. **Supervised Agriculture Experience in Vocational Agriculture.** Supervised agricultural experience programs as an educational strategy; importance and meaning of supervised agriculture experiences; planning, conducting, supervising, and evaluating agriculture experience programs; relation of supervised agriculture experience programs to establishment and advancement in an occupation; keeping and using records; relating class instruction to supervised agriculture experience programs. ½ unit. Prerequisite: Vocational and Technical Education 276 and 277, or consent of instructor. Phipps, Warmbrod.

475. **Organizing and Teaching Agriculture Mechanics.** Agriculture mechanics as a phase of vocational education in agriculture: purposes, course planning for high school students, young farmers, and adults; methods of teaching and evaluating on-farm or on-job instruction; planning agriculture-mechanics shops and facilities; providing and teaching safety in agriculture mechanics. ½ unit. Prerequisite: Vocational and Technical Education 276 and 277, or consent of instructor. Phipps.

476. **Guidance in Agricultural Education.** The guidance function in young farmers' and adult farmers' classes, determining and preparing for agricultural opportunities, personnel included in vocational classes, preparation of plans for teaching about agricultural occupations, tests and other aids in guidance, establishment, placement, follow-up. ½ unit. Prerequisite: Vocational and Technical Education 276 and 277, or consent of instructor.

481. **History and Basic Concepts of Vocational Education.** A course in the historical development of modern vocational education, the educational theories underlying its development, and the educational concepts upon which present programs and procedures are based. 1 unit. Campbell.

482. **Research Studies in Vocational and Technical Education.** Study and evaluation of examples of research in this field; a consideration of the research needed to solve present problems. Each student proposes and completes a brief research project, or plans in detail a major research project to be completed later. 1 unit. Baldwin, R. Evans, Phipps, E. Simpson.

487. **Seminar in Vocational, Technical, and Practical Arts Education.** Overview and interpretation of social, economic, and technological trends which have relevance to the problem of developing new programs in the vocational, technical, and practical arts areas; analysis and evaluation of innovations in the field; current issues and problems. 1 unit. Prerequisite: Graduate standing in vocational and technical education. M. R. Karnes, Phipps, E. Simpson.

488. **Curriculum Problems and Trends in Industrial Education.** Selection and organization of instructional materials for industrial courses; study of basic concepts underlying course construction in industrial education. 1 unit. Prerequisite: Undergraduate work in appropriate vocational and technical education courses. Campbell, Tomlinson.

489. **Administration and Supervision of Vocational and Technical Education.** Problems and approved practices in the administration and supervision of pro-

grams of vocational, technical, and practical arts education in secondary schools, junior colleges, and technical institutes. 1 unit. Prerequisite: Consent of instructor. M. R. KARNES, TOMLINSON.

490. **Seminar for Advanced Students of Education.** Seminar in vocational and technical education open only to persons who have been admitted for doctoral study in vocational and technical education. Sections of this seminar are usually offered in the following areas: (a) industrial education, (b) agricultural education, and (c) home economics education. 1 to 2 units. STAFF.

491. **Field Study and Thesis Seminar.** Usually required of candidates for the Doctor of Education. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to Ed. D. candidates. 1 to 2 units. STAFF.

499. **Thesis Research.** Individual direction of research and thesis writing. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

349. **Special Study and Investigation in Vocational and Technical Education.** A course to offer opportunity for an individual to study, on or off campus, selected problems, trends, and new developments; or to conduct specialized technological investigations for the improvement of instructional programs in areas related to vocational and technical education. ½ to 1 unit. Prerequisite: Consent of instructor; demonstrated ability to pursue special study or investigation proposed. STAFF.

370. **Agricultural Education for First-Year Teachers.** Specific help with the problems of beginning teachers. Campus meeting in August. Other meetings in centers in the state convenient to first-year teachers. Visits by instructors to schools in which first-year teachers are employed. ½ unit. Prerequisite: Vocational and Technical Education 276 and 277. FULLER, WALKER, WARMBROD.

381. **Principles of Vocational Education.** Study of basic concepts and practices of modern vocational education. ½ or 1 unit. TOMLINSON.

382. **Cooperative Vocational and Technical Education Programs.** This course is designed to provide the specific professional background required of teachers, coordinators, and administrators who organize and conduct public school programs utilizing community resources and experiences. The course includes the background, philosophy, organization, and administration of cooperative education. ½ or 1 unit. TOMLINSON.

383. **Development, Organization, and Principles of Industrial Education.** A survey of the problems and practices of the several phases of industrial education. ½ or 1 unit. TOMLINSON.

384. **The General Shop Program.** A laboratory and theory course in the organization and administration of the industrial arts general shop program. 1 unit. Prerequisite: Sixteen hours in appropriate vocational and technical education courses. TINKHAM.

387. **Training Programs in Industry.** A study of the organization, instruction, supervision, and evaluation of training programs conducted within industry, and their relationships to other educational agencies. 1 unit.

388. **Special Techniques of Teaching Vocational-Industrial Subjects.** A study of the application of principles of industrial education in vocational-industrial edu-

cation. Methods of developing industrial skills, appropriate vocational attitudes, and related technical knowledge are stressed. Lectures, discussions, and demonstrations. 1 unit. Prerequisite: Ten hours of undergraduate credit in appropriate vocational and technical education courses. CAMPBELL, TOMLINSON.

ELECTRICAL ENGINEERING

Graduate work in electrical engineering leading to the Master of Science and Doctor of Philosophy is offered to graduates of electrical engineering curricula substantially equivalent to that of the University of Illinois. Graduates of curricula in the physical sciences and mathematics may also be admitted to advanced study if they have the necessary background to profit from graduate work in electrical engineering. To be admitted, an applicant must have the equivalent of a grade-point average of 4.0 or B for the last sixty semester hours of undergraduate study. Courses for advanced undergraduates and graduates are also open for credit to qualified students majoring in other fields.

A minimum of eight units must be completed for the master's degree, including a thesis. At least four units must be at the 400 level, including a course in circuit theory and one in field theory. In addition, graduate or undergraduate credit in a modern physics course is required.

All students desiring to enter the doctoral program must take the electrical engineering qualifying examination. Students who earn the master's degree at the University of Illinois take the examination during the term they earn their eighth unit of graduate credit. Students who enter with the master's degree must take the examination during the first term here.

Eight units of course credit beyond the master's degree, or the equivalent, plus eight units of thesis research and a satisfactory thesis, are minimum requirements for the Doctor of Philosophy. In addition, the candidate must demonstrate reading proficiency in two of the following languages: French, German, Russian. He also must have completed two courses in modern physics. In his course program he must offer a major and either one or two minors. A single minor requires four units in one field outside the major field, at least one of which must be at the 400 level. If two minors are chosen, each must consist of at least two units. Advanced courses in mathematics, physics, physiology, chemistry, nuclear engineering, and other branches of engineering are recommended minors.

Further details may be found in the *Electrical Engineering Graduate Study Manual*, available from the department.

GRADUATE FACULTY

Professors: E. C. JORDAN (Head of Department), H. W. ADES, F. ADLER, G. E. ANNER, W. R. ASHBY, D. S. BABB, A. D. BAILEY, J. BARDEEN, D. A. BITZER, S. A. BOWHILL, R. M. BROWN, R. T. CHIEN, P. D. COLEMAN, J. B. CRUZ, G. A. DESCHAMPS, F. DUNN, J. D. DYSON, W. L. EMERY, W. L. EVERITT, G. H. FETT, W. J. FRY, L. GOLDSTEIN, P. HANDLER, H. N. HAYWARD, M. S. HELM, C. D. HENDRICKS, F. E. HOHN, N. HOLONYAK, JR., D. F. HOLSHOUSER, B. C. KUO, Y. T. LO, W. MAYEDA, P. E. MAYES, M. S. MCVAY, W. E. MILLER (Associate Head of Department), R. MITTRA, D. E. MULLER, S. MUROGA, G. R. PEIRCE, D. PINES, W. J. POPPELBAUM, J. E. ROBERTSON, C. T. SAH, P. F. SCHWARZLOSE, M. D. SIRKIS, L. STARK, G. W. SWENSON, JR., J. VLACH, H. M. VON FOERSTER, N. WAX, H. D. WEBB, K. C. YEH.

Associate Professors: W. G. ALBRIGHT, R. B. ASH, R. W. BURTNESS, J. H. CAHN, D. H. COOPER, M. H. CROTHERS, P. R. EGBERT, E. W. ERNST, F. J. FRY, O. L. GADDY, D. F. HANG, P. W. KLOCK, P. KOKOTOVIC,

J. O. Kopplin, P. E. Mast, G. A. Metze, T. A. Murrell, J. P. Neal, W. R. Perkins, S. R. Ray, C. F. Sechrist, J. T. Verdeyen.

Assistant Professors: D. P. Akitt, M. L. Babcock, J. W. Beauchamp, B. E. Cheerington, J. M. Crowley, A. W. Dipert, A. H. Haddad, C. H. Liu, H. Merkelo, N. Narayana Rao, F. P. Preparata, B. G. Streetman, T. N. Trick.

Research Associate: W. Q. Jeffers.

COURSES FOR GRADUATES

400. Seminar. Required of all graduate students. No credit.

412. Advanced Engineering Measurements. Theory and practice of precision measurements of electric, magnetic, and physical quantities; factors influencing the choice of method. Comparative accuracy and practicability of measurement methods and limitation of technique; evaluation of errors; design and development of measurement apparatus and methods. 1 unit.

414. Engineering Applications of Linear Graphs. Same as Computer Science 414. Elementary theory of linear graphs, Euler graphs; incidence, cut-set and circuit matrices and their properties; realizability of cut-set, circuit and tree matrices; applications to network analysis and synthesis; signal flow graphs; applications to switching circuits and automata; communication networks. 1 unit. Prerequisite: Electrical Engineering 416; Mathematics 315 or 318.

415. Control System Theory and Design. Synthesis of feedback control systems to meet design specifications, including sensitivity; multivariable systems; introduction to systems with random inputs; state variable techniques; nonlinear systems. 1 unit. Prerequisite: Electrical Engineering 386 or equivalent, or consent of instructor.

416. Analysis of Networks and Systems. Dynamic equations of linear lumped networks and systems; time-domain analysis and state space methods; frequency-domain analysis and transform methods; stability criteria. Applications to various problems in electrical engineering. 1 unit. Prerequisite: Credit or registration in Mathematics 346 or 348; Electrical Engineering 322.

418. Electric and Magnetic Fields. Rigorous treatment of basic laws, static fields, typical field systems, harmonic functions, conjugate functions, conformal transformation. 1 unit.

420. Electromagnetic Waves and Radiating Systems. Fundamental electromagnetic theory with applications to transmission lines, waveguides, and antennas; introduction to the solution of advanced problems in static electric and magnetic fields, 1 unit. Prerequisite: Electrical Engineering 352.

421. Advanced Electromagnetic Engineering. Reciprocity and equivalence principles; formulation of scattering and diffraction problems; approximations for large and for short wavelengths; plane cylindrical, and spherical wave problems; variational methods; Wiener-Hopf techniques; applications to antennas and waveguide problems. 1 unit. Prerequisite: Electricl Engineering 420.

423. Gaseous Electronics and Plasmas. Irreversible thermodynamics; transport theory; magnetohydrodynamics; collective behavior. 1 unit. Prerequisite: Physics 362 and Electrical Engineering 420, or equivalent.

425. Quantitative Neuroanatomy Lecture. Same as Physiology 425. A detailed consideration of (1) quantitative methods of studying structure in the central nervous system, (2) analysis of quantitative data concerning cell and fiber populations and related characteristics in both normal and modified brains, and (3) deriva-

tion of neuronal circuitry. 1 unit. Prerequisite: Physiology 416 or equivalent; consent of instructor.

426. **Quantitative Neuronanatomy Laboratory.** Same as Phsyiology 426. Practice in the use of quantitative methods for precisely determining nerve cell populations and other components of the central nervous system and in measuring properties of subcellular components of anatomic significance. 1 unit. Prerequisite: Physiology 416 or equivalent; consent of instructor.

427. **Boundary Value Problems.** Derivation and solution of partial differential equations and integral equations of mechanics and electricity and magnetism; study of the analysis of wave motions. 1 unit.

428. **Analysis of Nonlinear Systems.** Same as Theoretical and Applied Mechanics 428. Singular points and stability considerations are treated. Graphical and analytical methods, including the perturbation method, variation of parameters, Galerkin's method, and the Ritz method for solving nonlinear differential equations, are considered. 1 unit. Prerequisite: Mathematics 341; consent of instructor.

429. **Vacuum Tube Circuit Analysis.** Vacuum tube network theory, feedback circuits and amplifiers, stability, equalizers, and relations between components of network functions. 1 unit.

431. **Theory of Guided Waves.** Propagation in general cylindrical waveguides; eigenvalue problems; stationary principles; microwave circuit theorems, boundary value problems, and the determination of circuit parameters; periodically loaded waveguides with anisotropic media. 1 unit. Prerequisite: Electrical Engineering 420.

434. **Random Processes in Electrical Engineering.** Survey of measure theoretic probability theory; analysis of second order random processes, including the spectral theory and harmonic analysis; transmission of noise through linear and nonlinear systems; the signal detection problem. 1 unit. Prerequisite: Mathematics 361.

435. **Theory of Semiconductors and Semiconductor Devices.** Same as Physics 435. Introductory quantum mechanics of semiconductors; energy bands; dynamics of Bloch electrons in static and high frequency electric and magnetic fields; equilibrium statistics; transport theory, diffusion, drift and thermoelectric effects; characteristics of p-n junctions, heterojunctions, and transistor devices. 1 unit. Prerequisite: Physics 381 or 383.

437. **Principles of Microwave Measurements.** Generation and detection of the laboratory signal; the generalized impedance concept; matrix representation of waveguide discontinuities; determination of equivalent network parameters; analysis of measurement techniques by signal flow graphs; accuracy criteria. 1 unit. Prerequisites: Electrical Engineering 355 and 356.

438. **Stochastic Processes in Engineering.** Same as Aeronautical and Astronautical Engineering 453. Supplementing Aeronautical and Astronautical Engineering 452 or Electrical Engineering 434 for additional engineering applications of stochastic processes. Theories of random pulses and continuous Markov processes and their applications to dynamic and control systems; parametric excitations and stability; nonlinear devices; topics related to system failures. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 452, Electrical Engineering 434, or equivalent.

439. **Advanced Theory of Semiconductors and Semiconductor Devices.** Continuation of Electrical Engineering and Physics 435. Selected advanced topics of current interest in the physics of semiconductors and solid state devices. 1 unit. Prerequisite: Electrical Engineering and Physics 435.

440. **Advanced Power Circuit Analysis, I.** Analysis of power systems by symmetrical

and related components; equivalent circuits of lines, transformers, and machines; fault calculations on symmetrical and unsymmetrical power systems; the network analyzer in fault studies. 1 unit.

445. **Power System Stability.** Transient and steady-state stability in power systems; power flow equations; transient stability swing curves; critical clearing time; the network analyzer in stability studies; the analog computer in transient stability studies. 1 unit. Prerequisite: Electrical Engineering 440.

451. **Advanced Network Synthesis.** Characterization of N-ports; the scattering matrix; indefinite admittance matrix; broad band matching; N-port synthesis techniques; active network synthesis; sensitivity of networks. 1 unit. Prerequisite: Electrical Engineering 324; credit or registration in Mathematics 346 and Electrical Engineering 416.

452. **Time-Varying and Nonlinear Circuits.** Energy considerations; equations in normal form; frequency power relations in nonlinear networks; frequency conversion; Lyapunov's direct method; the circle stability criterion; calculus of variations and Hamilton's principle applied to the stability and matching problems. 1 unit. Prerequisite: Electrical Engineering 416; Mathematics 346.

453. **Optimum Control Systems.** Formulation of the optimization problem; controllability; observability; stability; Lyapunov's second method; application of variational calculus, maximum principle and principle of optimality to control problems; stochastic control; adaptive control. 1 unit. Prerequisite: Electrical Engineering 415.

454. **Sampled-Data Control Systems.** Analysis and design of feedback control systems with digital and sampled data. 1 unit. Prerequisite: Electrical Engineering 386 or 415, or equivalent.

456. **Coding Theory.** Same as Computer Science 456. General discussion on coding theory with emphasis on the algebraic theory of cyclic codes; error-control procedures and circuits; applications to computers and data-transmission systems. 1 unit. Prerequisite: Mathematics 317 or equivalent, or consent of instructor.

463. **Information Theory.** Same as Computer Science and Mathematics 463. Mathematical models for information channels and sources; existence theorems for and construction of error-correcting codes. 1 unit. Prerequisite: Mathematics 361 or equivalent.

465. **Topics in Automata Theory.** Same as Computer Science and Mathematics 465. Topics selected from mathematical systems and automata theory, decision problems, formal languages, decomposition theory, etc. 1 unit. Prerequisite: Computer Science, Electrical Engineering, or Mathematics 392, or consent of instructor.

467. **Atomic Collision Processes.** Same as Physics 467. Elastic collisions of electrons with neutral atoms; inelastic electron-atom and electron-molecule collisions; collisions between heavy particles; molecule formation; photoprocesses and recombination; negative ions; collisions involving the emission of radiation; theory of spectral line-broadening in plasmas; experimental techniques. 1 unit. Prerequisite: Physics 481; consent of instructor.

472. **Quantum Electronics.** A brief theoretical introduction to quantum mechanics and atomic physics, with many applications in spin resonance and modern maser theory. 1 unit. Prerequisite: Physics 381. It is recommended that Physics 362 and 385 be taken before registering in this course.

474. **Problems of Cybernetics.** Same as Biophysics and Communications 436. The study of brain-like processes in complex dynamic systems with emphasis on unsolved problems, current developments, and opportunities for research. 1 unit Prerequisite: Consent of instructor.

475. Ionospheric Radio Propagation. Propagation in a stratified medium; WKB solution; ray theory; ionospheric sounding; ionospheric transmission problems; scattering by irregularities; propagation in a random medium; cross-modulation and nonlinear effects; magneto-ionic theory; Faraday effect; whistler propagation; coupling of characteristic waves; magneto-hydrodynamic waves; formation of ionospheric E-region; formation of F-region. 1 unit. Prerequisite: Electrical Engineering 420 or equivalent.

481. Threshold Logic. Same as Computer Science 481. Mathematical model of computer elements which work under threshold or majority principle; mathematical theory of threshold functions; realizability using a linear programming approach; network syntheses of majority principle devices. 1 unit. Prerequisite: Consent of instructor.

482. Theory of Digital Computer Arithmetic. Same as Computer Science 482. This course emphasizes the use of redundancy in the representation of digits in order to increase the efficiency of computer arithmetic. Topics include multiplier recoding, division with redundantly represented quotients, and structural redundancy as implied by carry-save and signed-digit techniques. 1 unit. Prerequisite: Computer Science or Electrical Engineering 394.

485. Advanced Theory of Magnetic and Optic Computer Memory Devices. Same as Computer Science 485. Theory of ferromagnetism and superconductivity applied to memory devices; light propagation in anisotropic media: modulators and deflectors; principles of laser operation. 1 unit. Prerequisite: Electrical Engineering or Computer Science 385.

486. Constitution of the Ionosphere: An Introduction to Aeronomy. Same as Astronomy 486. Properties of the neutral and ionized atmosphere above 60 km. height, and the photochemical processes causing them; diffusion of ionospheric constituents; solar and meteoric perturbations of the ions of the ionosphere. 1 unit. Prerequisite: Graduate standing in electrical engineering, physics, or astronomy; Mathematics 341 or equivalent.

490. Seminar in Special Topics. Lectures and discussions on current research and literature on advanced topics in electrical engineering. Course may be repeated. 0 to ½ unit. Prerequisite: Advanced standing; consent of instructor.

497. Electrical Engineering Problems. Lectures and discussions relating to new areas of interest. 0 to 1 unit. May be repeated. Prerequisite: Consent of instructor.

498. Individual Study. Individual projects. ½ to 2 units. Prerequisite: Consent of instructor.

499. Thesis Research. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

322. Linear Network Theory, II. Signal representation in terms of Fourier series, Fourier transforms, and Laplace transforms; role of exponential and sinusoidal signals in system analysis for arbitrary waveforms; two-ports and filters as signal processors. 0 to 1 unit. Prerequisite: Electrical Engineering 250 and 251; Computer Science 101; Mathematics 345.

323. Circuit Laboratory. To accompany Electrical Engineering 322 and 350. 0 or ¼ unit. Prerequisite: Electrical Engineering 251 and 322; credit or registration in Electrical Engineering 350.

324. Introduction to Network Synthesis. An introduction to modern methods of network synthesis; properties of driving-point and transfer functions; approximation and scaling; LC, RC, and RLC synthesis methods; ladder network development; and resistively terminated coupling networks. 0 to 1 unit. Prerequisite: Electrical Engineering 322.

330. **Magnetic Circuits and Transformers.** Magnetic circuit analysis; transformer theory; special magnetic circuit applications. 0 to ¾ unit. Prerequisite: Electrical Engineering 229, 250, and 251; credit or registration in Electrical Engineering 331.

331. **Magnetic Circuits and Transformers Laboratory.** To accompany Electrical Engineering 330. 0 or ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 330.

332. **Electrical Machinery.** Induction machines; single-phase motors; direct-current machines; application. 0 to ¾ unit. Prerequisite: Electrical Engineering 330 and 331; credit or registration in Electrical Engineering 333.

333. **Electrical Machinery Laboratory.** To accompany Electrical Engineering 332. 0 or ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 332.

336. **Advanced Analysis of Electric Power Equipment.** Transformers, synchronous and induction machines; power machines in systems; single phase motors; extension of the two-reaction analysis to the general machine. 0 or 1 unit. Prerequisite: Electrical Engineering 330 and 331.

340. **Electronics, I.** Semiconductor materials and their electronic properties and applications to electronic devices; p-n junctions, transistors, and other diode and triode devices; low-frequency applications of diodes. 0 to ¾ unit. Prerequisite: Electrical Engineering 250.

341. **Electronics Experimentation.** Problems of experimentation and measurement with electronic circuits and devices. Lecture and laboratory. 0 or ¼ unit. Prerequisite: Electrical Engineering 251; credit or registration in Electrical Engineering 340.

342. **Advanced Electronics.** Linear and nonlinear amplification; modulation and demodulation concepts; introduction to feedback amplifiers and oscillators. 0 to ¾ unit. Prerequisite: Electrical Engineering 322, 340, and 341.

343. **Electronics Laboratory.** 0 or ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 342.

344. **Theory and Fabrication of Solid State Devices.** A laboratory and lecture course on the physical theory, design, and fabrication of solid state devices which includes the electronic properties of semiconductors (such as mobility, carrier concentration, lifetime, energy gap) and techniques for fabricating (oxidation, diffusion, oxide masking, alloying) p-n junction devices. 1 unit. Prerequisite: Electrical Engineering 340.

347. **Industrial Electronics.** Electronic circuits for automatic control and measurement systems with applications. 0 to 1 unit. Prerequisite: Electrical Engineering 322, 330, and 342. Credit toward graduation is not given for both Electrical Engineering 347 and 381.

349. **Nonlinear Electronic Circuits.** An introduction to the elementary solution of zero, first-, and second-order differentio-integral equations encountered in the study of electronic circuits. Circuits used as examples employ uni- and bipolar transistors, unijunctions, tubes, and other devices. Emphasis is given to nonlinear negative resistance applications in switching applications and in oscillators of the relaxation and quasi-sinuoidal types. ¾ or 1 unit. Prerequisite: Electrical Engineering 340.

350. **Lines, Fields, and Waves.** Transmission lines, field calculations, and wave propagation. ¾ unit. Prerequisite: Electrical Engineering 229; Computer Science 101; credit or registration in Electrical Engineering 323.

352. **Electromagnetic Fields.** Uniform plane waves, wave guides, radiation and propagation of electromagnetic energy, radiating systems, and electrodynamics. ¾

unit. Prerequisite: Electrical Engineering 350 and 323; concurrent registration in Electrical Engineering 356 is recommended.

353. **Radio Circuits.** Component behavior at communication frequencies, impedance transforming networks for single and multiple frequencies; low-level tuned and compensated amplifiers, broad band impedance matching; equalizers. 0 to 1 unit. Prerequisite: Electrical Engineering 322.

355. **Fields and Waves.** Electromagnetic fields; wave guides; radiation and propagation of electromagnetic energy; radiating systems. 0 or ¾ unit. Prerequisite: Electrical Engineering 229 and 350, or consent of instructor.

356. **Microwave Techniques.** UHF and microwave sources and detectors; laboratory techniques for UHF and microwave frequencies. 0 or ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 352 or 355.

357. **Radio Astronomy.** Same as Astronomy 357. Instrumental theory and observational techniques; radar and meteors; the moon and planets; solar radio waves; galactic and extragalactic radio astronomy. 1 unit. Prerequisite: Physics 108.

359. **Introduction to Noise and Information Transmission.** Signals and their spectra; methods of communication systems analysis; modulation by AM, FM, PAM, PPM; origin of noise, properties of noise, introduction to probability theory, system comparison using statistical approach. ¾ or 1 unit. Prerequisite: Electrical Engineering 322; credit or registration in Electrical Engineering 342.

366. **Aeronomy: Physics of Upper Atmosphere and Space.** Same as Astronomy and Physics 366. Structure and composition of the Earth's upper atmosphere, solar radiation and its interaction with the upper atmosphere; the ionospheric layers; planetary atmospheres; airglow and aurora; interplanetary plasma; the magnetic field of the Earth and its interaction with the solar plasma; experimental techniques. 1 unit. Prerequisite: Physics 342, 321 and 381, or consent of instructor.

367. **Active Networks.** A study of active device models and their application to electrical network equation forms. Systems are expressed in terms of their network functions; the characteristics of feedback systems are examined in particular. Sensitivity and stability factors are examined. ¾ unit. Prerequisite: Electrical Engineering 342.

373. **Engineering Acoustics.** Same as Theoretical and Applied Mechanics 373. Development of the basic concepts needed for the understanding of mechanical and electrical acoustic systems: vibrating string; vibrating membrane; plane waves; spherical waves; vibrating piston; accoustical filters; loudspeakers and microphones; principle of reciprocity; the ear; architectural acoustics. ¾ or 1 unit. Prerequisite: Mathematics 345 or equivalent, or consent of instructor.

376. **Symmetrical Component Analysis of Power Systems.** Representation of power systems; symmetrical components, positive, negative and zero sequence impedances of network components, sequence networks; unsymmetrical faults, unsymmetrical power systems, matrix algebra in symmetrical component analysis. 0 or 1 unit. Prerequisite: Electrical Engineering 350.

378. **Electric Power Networks.** Steady-state power network analysis; inductive coordination; transmission line capacitance and resistance; networks synthesis; application of computers to power network problems. 0 or 1 unit. Prerequisite: Electrical Engineering 350; credit or registration in Electrical Engineering 332.

381. **Pulse Techniques.** An introduction to the response of electrical networks to nonsinusoidal inputs, the analysis of active circuits with large signals, and the circuits and techniques used in pulse and digital equipment. Credit toward graduation is not given for both Electrical Engineering 381 and 347. 0 or 1 unit. Prerequisite: Electrical Engineering 322 and 341, or consent of instructor.

382. **Transistor Circuits.** This course is the same as Electrical Engineering 383 but has one three-hour laboratory added each week. 1 unit. Prerequisite: Electrical Engineering 340, 342, and 343, credit or registration in Electrical Engineering or Metallurgical Engineering 384, or consent of instructor.

383. **Transistor Circuits.** Junction transistors, diodes, and related semiconductor devices. Emphasis equally divided between device properties as related to semiconductor physics and circuit properties. Small signal theory of amplifiers and oscillators, large signal theory of power stages and switching circuits, negative resistance effects, high frequency limitations. ¾ unit. Prerequisite: Electrical Engineering 342, credit or registration in Electrical Engineering or Metallurgical Engineering 384, or consent of instructor.

384. **Properties of Solids.** Same as Metallurgical Engineering 384. Perfect and imperfect crystal lattices, electronic structure of solids, including basic theory, and applications to transport properties of metals and semi conductors, semiconductor diodes, dielectric and magnetic properties of solids. ¾ unit. Prerequisite: Physics 383.

385. **Theory of Semiconductor Computer Devices.** Same as Computer Science 385. Crystal conduction; large signal d-c and transient behavior of semiconductor devices; charge storage theory, phase plane diagrams, tolerance optimization, and noise theory; integrated circuits technology; masking, oxidizing, and etching; emphasis on device-theoretical background for computer logic design. ¾ or 1 unit. Prerequisite: Computer Science or Electrical Engineering 294, or consent of instructor.

386. **Fundamentals of Servomechanisms.** Fundamental knowledge required in the analysis of servomechanisms and automatic control devices. 0 or 1 unit. Prerequisite: Consent of instructor.

387. **Introduction to Quantum Electronics for Electrical Engineers.** Application of quantum mechanical concepts to electronics problems; for example: the generation and detection of coherent radiation, tunneling effects, and bulk oscillations in semiconductors. 1 unit. Prerequisite: Physics 383.

388. **Electronic Analog Computers.** Design of analog computer elements, problem preparation, and representative solutions of physical problems. 0 or 1 unit. Prerequisite: Electrical Engineering 340, 341, and Mathematics 345, or consent of instructor.

389. **Communication Design.** Over-all communication design problems; kinds of propagation; noise and interference; antenna temperature; transmitter power requirements; frequency selection; design of a portion of a receiver, transmitter, or antenna. 0 or ¾ unit. Prerequisite: Electrical Engineering 342 and 350.

391. **Boolean Algebra and Switching Theory.** Same as Computer Science and Mathematics 391. Boolean algebra with applications to sets, logic, electronic and relay combinational circuits; Karnaugh and Quine-McCluskey minimization procedures with applications; introduction to sequential circuits. ½ or 1 unit. Prerequisite: Consent of instructor.

392. **Introduction to Automata Theory.** Same as Computer Science and Mathematics 392. Semigroups, partially ordered sets, and other algebraic systems; asynchronous machines; abstract synchronous machines and their properties; regular sets; decomposition theory. ½ or 1 unit. Prerequisite: Computer Science, Electrical Engineering, or Mathematics 391, or consent of instructor.

393. **Digital Computer Circuit Design.** Same as Computer Science 393. Design of switching circuits and systems taking into account properties of currently available diodes, transistors, and related circuit elements; applications to slow-speed as well as high-speed computer circuits and data handling links; component

tolerance, circuit reliability, and cost factors are considered. 1 unit. Prerequisite: Computer Science or Electrical Engineering 294 or 391; Electrical Engineering 342; or consent of instructor.

394. **Logical Design of Automatic Digital Computer Circuits.** Same as Computer Science 394. A course in the design of automatic digital computers. Major emphasis is on logical structure of components and the interrelations necessary for automatic operation. 1 unit. Prerequisite: Computer Science or Electrical Engineering 294, or consent of instructor.

ENGLISH LANGUAGE AND LITERATURE

(Including American Literature and Rhetoric and Composition)

Students who wish to be considered for admission to graduate work in English must have attained a grade-point average of at least 4.0. However, students whose averages are between 3.75 and 4.0 are considered on an individual basis. All students must present the equivalent of at least twenty hours of undergraduate work in English or American literature, although students with at least fourteen hours may be considered on an individual basis and granted probational entrance. This does not include required college work in rhetoric.

Master of Arts in English. In addition to satisfying the general requirements of the Graduate College, candidates must take English 446 and are required to choose at least three of their courses from those at the 300 level and three from those at the 400 level. Candidates must complete two courses in each of three areas of study as recognized by the department and must demonstrate proficiency in one language chosen from French, German, or Russian.

Candidates must also pass a final examination. A master's thesis is not required, but each candidate must deposit one term paper with the department.

Master of Arts in the Teaching of English. Candidates must earn at least four units in English, at least two of them in courses at the 400 level, and they must take the final examination for master's candidates in English. They must also deposit one term paper with the department. Candidates must also have had the equivalent of at least two years of undergraduate work in French, German, Latin, Greek, Russian, or Spanish.

Specific requirements are divided into two programs, the first for those who have the Bachelor of Arts in English and the teacher's certificate, and the second for those who have the Bachelor of Arts in English but not the teacher's certificate. See pages 44 and 45.

For those with the certificate, the requirements are English, four units, including English 446 and at least one course above the 450 level; education, two units as follows: one unit in Educational Psychology 311 and 312, and one unit chosen from History and Philosophy of Education 301, 302, 303, 304, or 305; specialized courses for high school teachers of English, as follows; one unit of either Secondary and Continuing Education 456 or English 447; three-quarters unit of either English 387 or 370; electives as needed to total at least eight units.

For those without the certificate, the requirements are English, four units, including English 446 and at least one course above the 450 level; education, two units as follows: one-half unit in Educational Psychology 311, one-half unit in Educational Psychology 312, and one unit chosen from History and Philosophy of Education 301, 302, 303, 304, or 305; specialized courses for high school teachers of English, three-quarters unit in either English 387 or 370; electives, as needed to total eight units. In addition to these courses, the candidates must take, without graduate credit, Secondary and Continuing Education 241 and Educational Practice 242. This program is designed to permit candidates to complete their work and qualify for a certifi-

cate and master's degree in two semesters and a summer. Those who lack certain prerequisites, such as general psychology, may need a little more time.

Electives may be in English, in education, or in exceptional cases, in other subjects.

Master of Arts in the Teaching of English as a Second Language. Detailed information concerning the curriculum and requirements for this degree should be requested from Professor Katharine O. Aston, Director of Programs in English as a Second Language, 317 English Building.

Doctor of Philosophy in English. In addition to satisfying the general requirements of the Graduate College, candidates must take at least two units of work in problems courses—those courses numbered 450 and higher. The department recommends that all work be taken at the 400 level.

English 445 and 446. All entering graduate students are required to take English 446, Introduction to Advanced Graduate Study. Candidates for the doctorate are required, in addition, to take English 445 during their first academic year in residence.

Proficiency Examination. Graduate students entering the doctoral program after taking degrees at other institutions are required to take a proficiency examination early in their first semester—or summer session—of residence.

Foreign Languages. Each student must demonstrate proficiency in two languages chosen from French, German, or Russian; but, with the approval of the adviser and the head of the department, he may petition the Dean of the Graduate College to be allowed to substitute Latin or Greek for one of these languages.

Minor Subjects. Students may offer a double minor, which includes English philology and one other subject, or a sole minor in English philology.

Preliminary Examination. This examination is given in October, January, and April of each year. It consists of two parts, a written examination and an oral examination.

Thesis. The student must submit a statement of his thesis plan, outlining its main topics, to the adviser within a reasonable period—usually six months—after he passes his preliminary examination.

More detailed information may be obtained by requesting a mimeographed statement, "Graduate Studies in English," from the Director of Graduate Students, Department of English, 100 English Building.

GRADUATE FACULTY

Professors: A. L. Altenbernd (Head of Department), A. E. Barker, L. E. Berry, J. J. Campbell, E. H. Davidson, J. T. Flanagan, R. A. Gettmann, R. H. Green, G. Hendrick, A. G. Holaday, J. N. Hook, J. F. Lynen, B. A. Milligan, R. W. Rogers, C. H. Shattuck, D. A. Smalley, J. R. Squire, J. Stillinger, H. W. Wilson.

Associate Professors: Katharine O. Aston, E. J. Brandabur, R. L. Fumento, G. P. Haskell, F. E. Hodgins, U. M. Kaufmann, D. V. Kramer, R. J. Loftus, S. Millet, F. B. Moake, R. L. Schneider, A. L. Scott, G. Scouffas, J. K. Simon, G. B. Stillwell, R. H. Wasson, B. F. Wilkie.

Assistant Professors: R. R. Allen, Nina Baym, H. C. Cole, W. M. Curtin, J. A. Dussinger, S. R. Homan, J. R. Hurt, K. Kinnamon, C. Sanders, J. F. Stottlar, J. C. Stubbs, A. Tibbetts, J. B. Trahern, Mary Lynn Woolley, G. G. Wright.

English Literature and American Literature

COURSES FOR GRADUATES

401. **Old English: Anglo-Saxon.** An introduction to the language before 1000 A.D. 1 unit.

402. **Old English: Beowulf.** 1 unit. Prerequisite: English 401.

403. **History of the English Language.** A study of the development of the language from the earliest stages to the present time. 1 unit.

404. **Old English Literature and Its Cultural Background.** An intensive, critical examination of Old English prose and poetry exclusive of Beowulf. The texts studied vary from year to year, but particular attention is given to such important bodies of writing as the Elegies, the *Anglo-Saxon Chronicle*, and the works of Cynewulf, Aelfric, Alfred, and Wulfstan. 1 unit. Prerequisite: English 401 and 402.

405. **Middle English.** Introduction to Middle English dialects, with special emphasis the East Midland. 1 unit. Offered in 1968-1969 and in alternate years.

406. **Middle English Literature and Its Cultural Background.** English literature from 1100 to 1500 (excluding Chaucer), with emphasis on chronicle, romance, debate, lyric, and such major poems as *Pearl*, *Sir Gawain and the Green Knight*, and *Piers Plowman;* historical, social, and religious backgrounds. 1 unit.

407. **Studies in Chaucer and His Times, I.** A study of Chaucer and his contemporaries. The chief aim of this course is an intimate acquaintance with Chaucer's poetry and an appreciation of his art. 1 unit.

408. **Studies in Chaucer and His Times, II.** Continuation of English 407. 1 unit.

411. **Studies in Sixteenth-Century Literature, I.** 1 unit. MILLIGAN.

412. **Studies in Sixteenth-Century Literature, II.** Continuation of English 411. 1 unit. MILLIGAN.

413. **Studies in Shakespeare.** 1 unit.

414. **Studies in Elizabethan Drama.** 1 unit.

416. **Studies in Late Renaissance Thought and Literary Theory.** The development of cultural ideas—religious, social, educational—in representative prose writers of the late sixteenth century and of the seventeenth century (Hooker, Bacon, Burton, Browne, Milton, Dryden, and others) in relation to literary theory and practice. 1 unit. BARKER.

417. **Studies in Seventeenth-Century Poetry and Milton (1600-1640).** 1 unit. BARKER.

418. **Studies in Seventeenth-Century Poetry and Milton (1640-1700).** Continuation of English 417. 1 unit. Prerequisite: English 417. BARKER.

421. **Studies in Eighteenth-Century Literature, I.** 1 unit.

422. **Studies in Eighteenth-Century Literature, II.** Continuation of English 421. 1 unit.

423. **Studies in the Eighteenth-Century Novel.** 1 unit. MCBURNEY.

427. **Studies in the Romantic Movement, I.** 1 unit. GETTMANN.

428. **Studies in the Romantic Movement, II.** Continuation of English 427. 1 unit. GETTMANN.

431. **Studies in Victorian Literature, I.** 1 unit. SMALLEY.

432. **Studies in Victorian Literature, II.** Continuation of English 431. 1 unit. SMALLEY.

433. **Major Movements in Modern British Poetry and Drama.** A study of important movements, figures, and ideas which shaped the criticism and practice of modern poetry. 1 unit.

434. **Major Movements in Modern British Fiction.** A study of important movements,

figures, works, and ideas which shaped the criticism and practice of modern fiction. 1 unit.

437. **Studies in American Literature: 1600 to 1800.** Studies in the Puritan mind from Bradford through Jonathan Edwards and in the Enlightenment, with Franklin, Jefferson, Paine, and the first literary artists as the bases of inquiry. 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: A survey course in American literature or consent of instructor. DAVIDSON.

438. **Studies in American Literature After 1800.** A course which investigates literary movements, major writers, and intellectual and cultural ideas in American literature from 1800 to the present. The subject matter of the course varies each time it is offered. 1 unit. Prerequisite: Survey course in American literature or consent of instructor. DAVIDSON.

442. **Studies in Recent Literary Theory.** The analysis of representative critics and critical schools of the twentieth century; similarities and differences between them and older critics in the solutions proposed to the central problems of literary theory. 1 unit.

445. **Introduction to Advanced Graduate Study.** A consideration of the methods of literary scholarship. Required of all candidates for the degree of Doctor of Philosophy in English. ¼ unit.

446. **Introduction to Advanced Graduate Study.** A consideration of the methods and objectives of literary criticism and the profession of college English teaching. Required of all candidates for the degree of Doctor of Philosophy in English. ¼ unit.

447. **Background Materials for High School Teachers of English.** Investigation of the content that is desirable in high school literature and composition. S; 1 unit. HOOK.

448. **Literary Analysis for Teachers of English.** An examination of the theoretical considerations underlying various approaches to teaching literature at the high school and introductory college level. 1 unit. Prerequisite: Teaching experience at secondary or college levels.

450. **Problems in Bibliographical Method.** Same as Library Science 440. Work on individual bibliographical problems, with a study of bookmaking, manuscripts and their relation to the printed text, editorial problems, and literary forgeries. 1 unit. Prerequisite: Consent of instructor.

457. **Problems in Medieval Literature.** A conference and research course devoted to special problems, literary movements, and writers of the period. 1 unit.

458. **Problems in Sixteenth-Century Literature.** A conference and research course devoted to special problems, literary movements, and writers of the period. The subject matter of the course varies each time it is offered. 1 unit. Prerequisite: English 411, 412, or equivalent; or consent of instructor.

462. **Problems in Tudor Drama.** 1 unit. HOLADAY.

463. **Problems in Shakespeare.** 1 unit.

464. **Problems in Elizabethan Drama.** 1 unit.

466. **Problems in Seventeenth-Century Metaphysical Poetry and Prose.** Literary technique in relation to intellectual and religious problems in the poetry and prose of John Donne, his contemporaries and successors. 1 unit. Prerequisite: English 345 or 417, or consent of instructor.

467. **Problems in Milton and His Age.** 1 unit. Prerequisite: English 342 or 418 or consent of instructor. BARKER.

469. **The Stage History of Classic English Plays.** Same as Speech 469 and Theatre 469. Analysis and reconstruction of past productions of classic plays, with special

reference to Shakespeare. 1 unit. Prerequisite: One year of work in dramatic literature or theatre history; consent of instructor.

471. Problems in Eighteenth-Century Literature. A conference and research course devoted to special problems, literary movements, and writers of the period. The subject matter of the course varies each time it is offered. 1 unit. Prerequisite: English 421, 422, or equivalent; or consent of instructor.

476. Problems in Romantic Literature. A conference and research course concerning special problems, literary movements, and writers of the English Romantic period. The subject matter of the course varies each time it is offered. 1 unit. Prerequisite: English 427 and 428, or consent of instructor. STILLINGER.

478. Problems in Prose Fiction. 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Second-year graduate standing. GETTMANN.

479. Problems in Victorian Literature. Prerequisite: English 431 or 432 or consent of instructor. 1 unit. SMALLEY.

480. The English Novel in Transition, 1890-1914. An examination of the works of principal Edwardian novelists, chiefly John Galsworthy, Arnold Bennett, and H. G. Wells, in terms of the transition of the English novel from Victorian to modern. 1 unit.

484. Problems in Twentieth-Century English Literature. A conference and research course devoted to selected writers and critical movements of the period. 1 unit. Prerequisite: English 433 or consent of instructor.

486. Problems in American Criticism and American Culture. Papers and discussions on literary critics and historians who have used literature as an index to the problems of American culture, 1900-1959. 1 unit. Prerequisite: English 376.

488. Problems in American Literature and Cultural History. 1 unit. This course may be repeated for a total of two units. Prerequisite: A survey of American literature or consent of instructor. DAVIDSON, FLANAGAN.

491. Research in Special Topics. Research in selected topics by arrangement with the instructor. This course may be repeated for a total of two units. 1 unit.

497. Independent Reading. A course in individual readings from the areas of literature as offered by the department at the advanced undergraduate-graduate level. May only be taken concurrently with a 300-level course. No student may offer more than a total of ½ unit of English 497. Prerequisite: Consent of instructor of requisite 300-level course. ¼ unit.

499. Thesis Research. Guidance in writing theses for advanced degrees. 0 to 4 units. BARKER, BERRY, CAMPBELL, DAVIDSON, FLANAGAN, GETTMANN, GREEN, HOLADAY, HOOK, LYNEN, MCBURNEY, MILLET, MILLIGAN, SCOTT, SHATTUCK, SMALLEY, STILLINGER, STILLWELL, TYLER, WILSON.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. Historical Introduction to the English Language. Relation of English to other languages; major phonological, morphological, syntactic, and lexical changes in English from the beginnings to the present. ¾ unit. Prerequisite: English 246.

310. Literature for the High School. An introduction to the guidance of high school readings in literature, including a survey of books of graduated difficulty through an individualized program of independent reading, an examination of reference tools and teaching materials in English, but with chief emphasis upon an intensive critical study of representative works. ¾ unit.

311. Chaucer. ¾ unit. STILLWELL.

316. **American Drama from 1900 to 1960.** A survey of American dramatic literature of the twentieth century, including the reading of a large number of plays which illustrate the diversity and importance of modern American drama. Special attention is given to the work of Maxwell Anderson and Eugene O'Neill. ¾ unit. FLANAGAN.

325. **English Literature from 1500 to 1660.** Survey of English literature of the Renaissance, exclusive of Milton and the drama. ¾ unit. MILLIGAN.

326. **Spenser and His Contemporaries.** A study of the principal preoccupations and forms of Elizabethan poetry, with special reference to Spenser. ¾ unit. Prerequisite: Six hours of English literature.

336. **English Drama Exclusive of Shakespeare.** From 1600 to 1700. ¾ unit.

338. **Tragedy.** Comparative study of masterpieces in several periods of Western culture. Major emphasis on ancient Greek and Roman, and English Elizabethan and Stuart drama. ¾ unit.

339. **Comedy.** The history and theory of comic drama. ¾ unit. SHATTUCK.

340. **Satire.** Comparative study of the chief nondramatic satires of Western civilization, from Roman times to the present. Particular emphasis is given to the bearing these works and traditions have on English satire. ¾ unit. Offered in 1968-1969 and in alternate years.

342. **The Poetry of Milton.** Origins, forms, artistic and ethical values; Milton's place in English literary history. ¾ unit.

345. **The Metaphysical Poets.** Class reading and discussion of the poetry of the principal members of the group known as the Metaphysical Poets (Donne, Herbert, Vaughn, Crashaw), with special emphasis on the poetry of John Donne. ¾ unit. MILLIGAN.

346. **The Age of Dryden.** A study of Restoration literature, dramatic and nondramatic, centered around Dryden. ¾ unit.

348. **Swift, Pope, and Fielding.** A study of the principal ideas and methods of satire as revealed in the writing of the three major English satirists. Written reports and extensive readings. ¾ unit. Prerequisite: A course in English literature.

349. **Dr. Johnson and His Circle.** The principal writings of Johnson, Boswell, Goldsmith, Reynolds, Burke, Gibbon, and Sheridan; the position of Johnson's circle in the social and literary life of the second half of the eighteenth century. ¾ unit.

351. **The Mid-Victorian Novel.** Thackeray, Emily Brontë, Mrs. Gaskell, Dickens, George Eliot, Trollope. ¾ unit. SCHNEIDER.

352. **American Literature: Irving to Whitman.** A study of the major American writers from 1800 to the Civil War, with particular emphasis on Cooper, Poe, Emerson, Thoreau, Hawthorne, Melville, and Whitman. ¾ unit. DAVIDSON.

354. **Studies in Middle Western Literature, II.** A survey of Middle Western literature from 1900 to the present, with special emphasis on the development of realism in poetry and fiction. ¾ unit. Offered in 1968-1969 and in alternate years. Prerequisite: One course in American history or one of the following: English 113, 114, 255, or 256. FLANAGAN.

359. **The International Folk Tale.** Same as Comparative Literature 359. A study of the origin, distribution, and nature of the folk tale with special reference to themes and variants. Representative tales of various areas (Africa, Germany, Greece, India, Ireland, Japan, Norway) are analyzed, and North American Negro and Indian tales are discussed. ¾ unit.

360. **The Popular Ballad and the Folk Song in the United States.** A study of the British and Scottish popular ballad—the Child ballad as it is familiarly known—as

it developed in Great Britain and as it was transplanted to the United States, with special emphasis on the development of native American ballads and songs. ¾ unit. FLANAGAN.

363. **Advanced Dramatic Writing.** Same as Speech 363, Radio and Television 363, and Theatre 380. Application of principles of dramatic form and structure to the more complex problems of playwriting. Practice in writing sustained dramatic forms. ½ or 1 unit; students may accumulate 2 units of credit. Prerequisite: Speech 263 or equivalent; consent of instructor. SMALLEY.

370. **Theory and Practice of Written Composition.** History and theory of written composition; basic rhetorical principles; guidance and criticism of student writing. ¾ unit.

375. **Henry James and the Technique of Fiction.** A study of the development of Henry James as a novelist, of influences upon him, and of his influence on novelists of the twentieth century, chiefly American. ¾ unit.

376. **American Criticism and American Culture.** This course examines the basic problem of the relation of literature to the Republic as a continuing historical issue; the idea of a national literature, the function of the artist in a democracy, the content and range of American criticism. The analysis centers on the major American critics. ¾ unit. Prerequisite: English 113 and 114 or English 255 and 256.

377. **Major American Poets.** A study of Poe, Whitman, Dickinson, Frost, Eliot, and Cummings with emphasis upon critical interpretation of their writings and the kinds of literary form characteristic of them. ¾ unit. Prerequisite: A course in English or American literature. LYNEN.

378. **Modern American and British Fiction in Its European Background.** A study of the interrelationship between certain themes and techniques in the development of the contemporary American, British, and European novel (from Dostoevsky, Melville, and Conrad through Mauriac, Dos Passos, Kafka, Gide, Faulkner, and Sartre to the present day). ¾ unit. Prerequisite: Two college-level literature courses.

380. **Mark Twain and the Rise of Realism.** A study, with special emphasis upon Mark Twain, of the rise of realism in American fiction from 1850 to 1900. ¾ unit. Prerequisite: English 114 or 256, or consent of instructor. SCOTT.

381. **Themes and Movements in British Literature.** An intensive study of a recurrent idea or of a literary situation. ¾ unit. Prerequisite: Six hours of English or American literature.

382. **The Plays of Bernard Shaw.** ¾ unit. SHATTUCK.

384. **Comparative Studies in Twentieth-Century Poetry.** A study of contemporary poetry in English in its relationship to modern European verse. The poets studied may vary each time the course is offered. ¾ unit. Prerequisite: Three hours in either poetry or modern literature, or consent of instructor.

385. **Themes and Movements in American Literature.** An intensive study of a recurrent idea or of a literary situation. ¾ unit. ALTENBERND, HODGINS.

386. **Modern English Grammar and Usage.** Traditional and contemporary grammars; principles of usage. ¾ unit.

387. **The Structure of English.** Same as Linguistics 387. Critical evaluation of traditional and structuralist grammatical descriptions; introduction to transformational grammatical studies; detailed survey of a transformational syntax of English; brief introduction to generative phonology and morphophonemic analysis of English, especially stress. ¾ unit.

Rhetoric and Composition

COURSES FOR GRADUATES

400. **Verbal Communication in English as a Second Language for Graduate Foreign Students, I.** A language laboratory course concentrating on the typical writing problems that a graduate or research student encounters in an American university. No graduate credit. Prerequisite: Rhetoric 111 or consent of instructor.

401. **Verbal Communication in English as a Second Language for Graduate Foreign Students, II.** A language laboratory course dealing with individual, immediate, and specialized speaking and writing problems, with particular attention to orienting the graduate student to the techniques of the American university in thesis and other specialized writings and in the oral presentation of such material. No graduate credit. Prerequisite: Rhetoric 400 or consent of instructor.

419. **Contrastive Linguistics.** Same as Linguistics 419. A critical survey of contemporary linguistic models with special reference to their relevance in preparing constrastive analyses of languages; detailed discussion on contrastive analyses of English and selected non-western languages at different linguistic levels. ½ or 1 unit. Prerequisite: Linguistics 300 or consent of instructor.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

330. **The Writing of Poetry.** The practice of the writing of poetry, aided by intensive study of examples. ¾ unit. Prerequisite: Six hours of English or American literature, or consent of instructor.

388. **Linguistics in Language Learning, I.** Same as Linguistics 388. The application of linguistic methods in the learning of a second language, with special emphasis on the learning of English. ¾ unit. Prerequisite: Two years of a foreign language or equivalent; consent of instructor.

389. **Linguistics in Language Learning, II.** Same as Linguistics 389. Applied linguistics in teaching and learning English as a second language, with special emphasis on the application of some principles of psycholinguistics, sociolinguistics, and ethnolinguistics along with the related disciplines of education, psychology, and anthropology to structured teaching/learning situations. ¾ unit. Prerequisite: Rhetoric 388.

ENTOMOLOGY

See descriptions and course listings under Life Sciences, page 250.

EXTENSION EDUCATION

This program leads to the professional degree of Master of Extension Education and is open to persons holding a bachelor's degree in agriculture, home economics, or a closely related area. Admission to the program requires a grade-point average of at least 3.5 for the last sixty semester hours of undergraduate work.

Candidates are required to complete a minimum of eight units, and nine units are required if a thesis is not submitted. Three of these units must be in 400-level courses with one unit in the major field. A major (four units) may be taken in agriculture, home economics, or the social sciences. Students majoring in agriculture or home economics select four additional units from the social sciences; those majoring in the social sciences select four additional units from agriculture or home economics.

All courses selected must be approved by the student's adviser. If a thesis is not submitted, the ninth unit may be selected in any area approved by the adviser. Students majoring in home economics must take work in three of the four major divisions of the department, unless proficiency in one or more of the areas is demonstrated by examination. At least four units must be earned in residence on the Urbana campus. Total extramural credit can not exceed three units.

Inquiries concerning the Master of Extension Education should be directed to Professor Ernest W. Anderson, 116 Mumford Hall.

FINANCE

The Department of Finance offers graduate work leading to the Master of Science and Doctor of Philosophy in Finance. The following fields are available for specialization within the department: money, credit, and banking; corporation finance; corporation history; investment; insurance; urban land utilization.

The grade-point average required for admission to graduate study in the department is 4.0, although applications of students with averages below 4.0 but above 3.75 may be considered on an individual basis. A candidate for a degree in finance must also meet the general admission requirements of the Graduate College. He must also have had (1) at least twenty-seven hours of undergraduate work in social science, fifteen hours of which must have been in economics, including a course in principles of economics, a course in statistics, and other courses for which the course in principles is a prerequisite, and (2) sufficient background in the finance area and the related fields of accountancy and business administration to support, in the judgment of the graduate adviser, the candidate's educational objective.

A candidate who elects finance as a minor for either the master's degree or the doctorate must have had (1) at least twelve hours of undergraduate work in social science, eight hours of which must have been in economics, including a course in principles of economics and other courses for which the course in principles is a prerequisite, and (2) sufficient background in the finance area and in the related fields of accountancy and business administration to support, in the judgment of the graduate adviser, the candidate's educational objective.

One year of graduate study in economic theory and a thesis are required as part of the minimum eight units for the master's degree in finance.

A candidate for the Doctor of Philosophy must pass a preliminary examination. Graduate study in accountancy or statistics, or both, is advised strongly for doctoral candidates majoring in finance.

The Doctor of Philosophy program for the first year must include (1) two units of economic theory, (2) four units of finance, and (3) two additional units in finance or related fields. Two of the finance units should be in thesis research. The second year of study includes eight units which provide (1) a concentration in finance, (2) understanding of one or more fields in economics in addition to economic theory, and (3) proficiency in any other related minor field offered.

GRADUATE FACULTY

Professors: P. M. Van Arsdell (Head of Department), C. T. Arlt, R. W. Mayer, R. I. Mehr, R. C. Osborn.

Associate Professors: T. E. Cammack, J. W. Leonard.

Assistant Professors: C. K. Evans, J. A. Gentry, C. M. Linke, J. R. Pike.

COURSES FOR GRADUATES

420. Central Banking Policy. An examination of modern theories of monetary man-

agement, gold standard theories, central banking, fiscal policy, debt management, and their relation to monetary policy. 1 unit. ARLT.

425. **The Money Market and Financial Stabilization.** A study of interest rate determination; the structure and operations of the money and capital markets; the objectives and implementation of monetary, fiscal, and debt management policies. 1 unit. Prerequisite: Finance 150. ARLT.

427. **Commercial Bank Managment.** A study of the principal policies and problems which confront top management. Major emphasis is given to liquidity, loans, investments, deposits, and capital funds, but consideration is also given to bank statements, organization structure, operations, personnel, cost analysis, and public relations. Instructional methods utilize readings, cases, and research projects. 1 unit. Prerequisite: Finance 150. BRYAN.

454. **Corporation Finance.** Nature of corporation finance and its relation to economics, accounting, and law; development of business corporation; concepts of capital, capitalization, and capital stock; nature of equities in corporation; financial analysis and interpretation; nature and development of financial plans; corporate securities and their adaptation to financial plan; initial and promotional financing; current capital financing; income administration; refinancing. 1 unit. Prerequisite: Finance 254. VAN ARSDELL.

455. **Corporation Finance.** Expansion; consolidation, concentration, and intercorporate relations; the corporate institution and the problem of monopoly and competition; corporate failure and reorganization; corporate financial management and the economy. 1 unit. Prerequisite: Finance 254. VAN ARSDELL.

456. **Investment.** A study of the financial process by which savings are transformed into capital with emphasis on the theory of investments, on a critique of investment policy, and on the valuation of investment media. 1 unit. MAYER.

460. **Theory of Insurance.** A study of the nature and cost of risk in our economic society and of the methods of handling it. 1 unit. MEHR.

490. **Individual Study and Research.** Directed reading and research. ½ to 1 unit. STAFF.

499. **Thesis Research.** Required for those writing master's and doctor's theses in finance. 0 to 4 units. MEHR.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

340. **Consumer Finance.** Nature and importance of consumer finance; trends in consumer credit; instruments and institutions of consumer credit; economic effects of consumer finance; consumer credit and public policy. ½ to 1 unit. Extra work is required of graduate students who register for 1 unit. Prerequisite: Finance 150 and 254, or consent of instructor.

350. **Capital Investment Management.** Designed to develop an understanding of the complex problems related to financial management; the development of an analytical framework for capital investment decision making; the study of capital investment problems through the use of selected cases. ½ to 1 unit. Prerequisite: Finance 254.

357. **Financing Small Business.** Size and nature of small business; significance and limitations of small business; financial structure and problems; financial assistance to small business; future prospects of small business. ½ to 1 unit. Prerequisite: Finance 254 or 257. OSBORN.

359. **Security Analysis.** Application of investment principles to investment policy; analytical principles and techniques; analysis of fixed income corporate securities, of senior securities with speculative features, of common stocks, of government

and municipal securities, and of investment company securities. ½ to 1 unit. Prerequisite: Accountancy 108; Finance 254. MAYER, PIKE.

360. Employee Benefit Plans. Same as Labor and Industrial Relations 360. An analysis of the economic and financial issues involved in designing and administering employee benefit plans; major emphasis is given to group life, disability income, and medical care plans and to "qualified" pensions and profit-sharing plans for regular employees; some attention is given to special, supplementary plans for the executive employees. ½ to 1 unit. Prerequisite: Finance 260, Economics 240, or Industrial Administration 351; or consent of instructor. MEHR.

363. Estate Planning. A study of the application of life insurance to the problems of family security, business security, investments, and estate protection. ½ to 1 unit. Prerequisite: Finance 262. MEHR.

368. Survey of Urban Real Estate. A broad survey of the field of real estate and urban land economics. Particular emphasis is given to the factors determining real estate values, the techniques of real estate valuation, and the principles of land utilization, development, management, marketing, and financing. ½ to 1 unit. Prerequisite: Six hours of economics or consent of instructor. EVANS.

369. Urban Land Problems. A problems course for students interested in undertaking detailed analysis of urban land problems. Problems are selected for individual study. Whenever possible the problems are selected and developed jointly with the departments of Urban Planning, Landscape Architecture, Architecture, and others. ½ to 1 unit. Prerequisite: Finance 368 or consent of instructor. EVANS.

370. Risks and Risk Management. Analysis of the financial problems in the risks of property damage or bodily injury in business situations and evaluation of the alternative methods of dealing with such problems. ½ to 1 unit. Prerequisite: One of the following: Accountancy 105 or 201; Economics 103 or 108; Finance 254 or 257.

FOOD SCIENCE

(Including Dairy Technology)

The Department of Food Science offers graduate work leading to the Master of Science and Doctor of Philosophy in Food Science or Dairy Technology.

A student planning to major in food science should have a Bachelor of Science degree in a recognized field of biological, physical, agricultural, or engineering science with credit in the following specific areas: physics, eight hours; calculus, five hours; physical chemistry, four hours. Students lacking these requirements will have an opportunity to fulfill them.

In order to major in dairy technology, a student should have a Bachelor of Science degree in any of the above listed fields of science.

The grade-point average required for admission to graduate study is 3.75, but applications from students with averages below 3.75 but above 3.5 may be considered on an individual basis.

Master of Science.

Food Science. To obtain a master's degree in food science, a student must have credit in Chemistry 350 and 355 (biochemistry), Microbiology 311 and 312, and Food Science 301, 302, 421 (one-fourth unit), and 499 (two units). The remainder of the eight units of credit required for the Master of Science consist of graduate courses selected from inside and/or outside the department which, in the opinion of the student and his adviser, are appropriate for the training and development of the student in the field of his specialization.

Thesis research may be carried out in any one of the following fields of specialization: food chemistry, food engineering, food microbiology, and food processing. The

student must present a thesis on his research and is required to take an oral examination covering the field of general food science and his specialization.

Dairy Technology. To obtain a master's degree in dairy technology, a student must have credit in Chemistry 350 and 355, Dairy Technology 401, 404 (one-fourth unit), and 499 (two units). A course in statistics (graduate or undergraduate) is also required.

The general provisions for a Master of Science in dairy technology are the same as in food science except that the fields of specialization apply to dairy products and the master's examination covers the field of dairy technology.

Doctor of Philosophy.

Food Science. In addition to the courses required for the Master of Science degree, candidates for the degree of Doctor of Philosophy in food science must have additional credit in Food Science 421 (one-fourth unit) and 499 (eight units). The remainder of the sixteen units of credit required for the degree will consist of graduate courses selected from inside and/or outside the department which in the opinion of the student and his adviser are appropriate for the training of the student in his field of specialization. Upon the completion of all formal course work, or during the last semester of such course work, and upon the satisfaction of the Graduate College language requirements, the student is required to take a series of written preliminary examinations in food science. The final eight units after passing the preliminary examination must be spent on thesis research. Upon the submission of his thesis, the candidate is required to defend his thesis orally before a faculty committee.

Dairy Technology. In addition to the courses required for the Master of Science degree, candidates for the degree of Doctor of Philosophy in dairy technology must have credit in Dairy Technology 403 and 404 (one-fourth unit) and 499 (eight units). They are also required to attend all seminars in dairy technology (Dairy Technology 404). The general provisions for a Doctor of Philosophy in dairy technology are the same as in food science, except that the written preliminary examinations for the doctorate are in the fields of dairy technology, dairy chemistry, and dairy microbiology.

Language Requirements. Candidates are allowed to use Spanish in addition to the languages listed by the Graduate College. A foreign student may petition to substitute his native tongue for one of these. If the petition is approved, he need only demonstrate reading proficiency in one of the specified languages and pass a qualifying examination in English.

GRADUATE FACULTY

Professors: R. T. Milner (Head of Department), J. H. Hetrick, L. B. Howard, F. A. Kummerow, A. I. Nelson, Z. J. Ordal, M. P. Steinberg, J. Tobias, S. L. Tuckey, R. M. Whitney, L. D. Witter.

Associate Professors: T. Nishida, H. K. Wilson.

Assistant Professors: C. Argoudelis, K. A. Narayan, E. G. Perkins, D. Sgoutas, L. Wei.

Food Science

COURSES FOR GRADUATES

404. **Special Topics in Food Science, III: Technology of Fats and Oils.** A study of the commercial technology of fats and oils, including soaps and protective coating. Offered in 1968-1969 and in alternate years. ½ unit. Prerequisite: Food Science 391 or consent of instructor. Narayan.

406. **Special Topics in Food Science, IV: State and Metabolism of Lipids.** An advanced study of the state of lipids in animal tissues and in biological fluids, and of the metabolism of lipids in relation to dietary fats and other food constituents.

Offered in 1968-1969 and in alternate years. 1 unit. Prerequisite: Chemistry 350 or consent of instructor. NISHIDA.

421. Seminar. Discussions on specialized topics and current literature relating to food technology. Required of all graduate students in food science. ¼ unit. STAFF.

430. Carbohydrates in Foods. Same as Home Economics 430. A study of the physical and chemical properties of carbohydrates used in foods and their behavior under conditions encountered in food processing and storage. ¾ unit. Prerequisite: Chemistry 355, 354, or 350, or consent of instructor.

499. Thesis Research. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Special Problems. Supervised research on special problems in food science and dairy technology. ¼ to 2 units.

301. Food Processing. Lectures, discussions, and pilot-plant demonstrations and experiments in preservation of foods by canning, freezing, dehydrating, and fermenting methods. Evaluation of product quality by subjective and objective methods and consideration of factory quality control factors. Field trips to commercial food plants. 1 unit. Prerequisite: Chemistry 133; Food Science 201. NELSON, WEI.

302. Food Processing. Lectures, discussions, and pilot-plant demonstrations and experiments in food manufacture including formulation of food preparations from fruits, vegetables, and cereals; preservation of meats and poultry products; vacuum and freeze drying of foods; evaluation of product quality by subjective and objective methods and consideration of factory quality control factors. Field trips to commercial food plants. 1 unit. Prerequisite: Chemistry 133; Food Science 202 and 301. NELSON, WEI.

322. Principles of Sanitation in the Processing and Handling of Foods. A study of the principles of sanitation with appropriate emphasis on practical considerations as they apply to various food processing industries. Control of insects, rodents, and micro-organisms; fundamentals of detergency; sanitation of water supplies; waste disposal methods; government and public health regulation. Local field trips to food processing plants. ½ unit. Prerequisite: Microbiology 100 and 101; Chemistry 102. ORDAL, WITTER.

363. Introduction to Process Engineering. Same as Chemical Engineering 363. Fundamentals of heat transfer, fluid flow, evaporation, drying, and other unit operations in the process industries. For students in chemistry, engineering, and food science; not open to majors in chemical engineering. Lectures and problems. ¾ unit. Offered in 1969-1970 and in alternate years. Prerequisite: Calculus or consent of instructor.

373. Advanced Food Microbiology. A study of the microbiology of those foods, food processes, or food ingredients, the production of which involves the biological or enzymatic activities of bacteria, yeasts, or the higher fungi. 1¼ units. Offered in 1969-1970 and in alternate years. Prerequisite: Chemistry 133; Microbiology 311 and 312. ORDAL, WITTER.

391. Special Topics in Food Science, I: Chemistry of Lipids in Foods. A detailed survey of the chemical and physical properties of lipids. Offered in 1968-1969 and in alternate years. ½ unit. Prerequisite: Credit or registration in Chemistry 350, or consent of instructor. PERKINS.

393. Special Topics in Food Science, II: Experiments in Lipid Chemistry. Laboratory exercises, demonstrations, and assigned readings. Offered in 1968-1969

and in alternate years. ½ unit. Prerequisite: Registration in Food Science 391 or consent of instructor. ARGOUDELIS.

Dairy Technology

COURSES FOR GRADUATES

401. **Advanced Principles of Dairy Technology.** Study of fundamentals and fundamental problems involved in the processing of milk and milk products. 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Chemistry 350. HERREID.

403. **Colloid Phenomena of Dairy and Other Food Products.** A study of the colloidal phenomena involved in the processing of dairy and other food products. 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Consent of instructor. WHITNEY.

404. **Seminar.** Review of current literature in dairy technology. ¼ unit; students may register for credit only twice for a maximum of one-half unit. STAFF.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. **Dairy Plant Management.** Problems in the organization, financing, labor management, and operation of dairy plants. ½ unit. Prerequisite: Consent of instructor. WILSON.

310. **Dairy Product Processing.** Theory and practice of receiving, preheating, pasteurizing, sterilizing, and homogenizing milk and cream for market, cultured milk and cream, powdered cream, frozen milk and cream, concentrated milk, dried milk, and ice cream. 1 unit. Prerequisite: Food Science 201; Dairy Technology 211; credit or registration in Dairy Technology 213. HERREID.

311. **Dairy Product Processing.** Theory and practice of the processing and manufacture of dairy products which are relatively nonperishable, such as butter, butter oil, cheese, casein, lactic acid, lactose, and fermentation products of whey. 1 unit. Prerequisite: Dairy Technology 211 and 213. TUCKEY.

312. **The Chemistry of Milk and Milk Products.** Chemical composition of dairy products and the chemical changes that occur during their manufacture and storage. Offered in 1968-1969 and in alternate years. ¾ unit. Prerequisite: Chemistry 133; Dairy Technology 312 or Chemistry 122. WHITNEY.

FORESTRY

The Department of Forestry offers graduate work leading to the degree of Master of Science in Forestry to graduates of forestry curricula substantially equivalent, in scope and standards, to those of the University of Illinois. The minimum grade-point average for admission to graduate study is 3.75. The program is intended for the forestry graduate who desires to deepen his understanding of the scientific principles which underlie some particular phase of forestry, such as ecology, economics, entomology, genetics, measurements, soils, airphoto interpretation, or wood science.

In consultation with his adviser, a student plans a program which meets the general requirements of the Graduate College and serves his particular needs and interests. Such a program must include a seminar in forestry and, in most instances, original research and the presentation of a thesis on an appropriate problem. The thesis requirement may be waived only if, in the judgment of the departmental grad-

uate committee, such waiver will result in a better program in a specific case. Advanced courses related to the student's special interest are found in such areas as biometrics, botany, climatology, economics, entomology, genetics, mathematics, photogrammetry, plant pathology, and soil science (see under departmental listings).

A candidate must earn eight units of graduate credit, with at least three units in courses at the 400 level. He must also pass an oral examination covering the general field of forestry and the area of his specialization.

GRADUATE FACULTY

Professors: T. E. Avery (Head of Department), W. R. Boggess, I. I. Holland, C. S. Walters.

Associate Professors: A. R. Gilmore, R. G. Rennels.

Assistant Professor: J. J. Jokela.

COURSES FOR GRADUATES

400. Seminar. Discussions on specialized topics and current literature in forestry. Required of all graduate students in forestry. ¼ unit. May be taken twice for a total credit of one-half unit. Staff.

401. Special Problems. Individual studies or investigations in selected branches of forestry. ½ to 1 unit. Not more than one unit may be offered for an M.S. degree. Staff.

440. Design and Analysis of Biological Experiments, I. Same as Agronomy, Animal Science, Dairy Science, Horticulture, and Veterinary Medical Science 440. A study of statistical methods as tools for research. Principles of designing experiments and the methods of analysis for various kinds of designs are considered from the viewpoint of when and how to use available simpler designs and analytical methods. 1 unit. Prerequisite: Consent of instructor. Carmer.

441. Design and Analysis of Biological Experiments, II. Same as Agronomy Animal Science, Dairy Science, Horticulture, and Veterinary Medical Science 441. A continuation of Forestry 440 moving into the more complex designs and methods of analysis. 1 unit. Prerequisite: Forestry 440 or equivalent. Carmer

499. Thesis Research. Research may be conducted in various phases of forestry. Subject must be approved by departmental committee. 1 to 3 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

315. Forest Soils. Soil factors related to forest hydrology and tree growth. Graduate students are required to attend a special seminar. ½ unit. Prerequisite: Agronomy 101 and Forestry 212; or graduate standing in botany with Botany 381 or equivalent. Boggess.

362. Forest Entomology. A study of the characteristics, life histories, and forest relationships and controls of the economically important forest insects of the United States. ½ unit. Prerequisite: One year of biological science; one year of chemistry. Rennels.

FRENCH

The Department of French offers graduate work leading to the Master of Arts Master of Arts in the Teaching of French, and Doctor of Philosophy.

Students are admitted with a minimum grade-point average of 4.0. Application

of students with grade-point averages below 4.0 but above 3.5 are considered on an individual basis.

Students electing French as a major subject should have had a college major in French, including practical work in the use of the language and advanced work in literature. Some knowledge of other Romance languages and literatures is desirable. A reading knowledge of Latin based on three years of high school Latin or three semesters of college Latin and a reading competence in German are required for the doctorate.

Students choosing French as a minor subject are admitted to courses for which they are adequately prepared.

Master of Arts in French. In addition to fulfilling the general requirements of the Graduate College, candidates must pass an examination based on a general reading list. Candidates preparing to teach French must take French 311, 313, and 314 unless they can demonstrate proficiency.

Doctor of Philosophy in French. Candidates are expected to take at least two units in seminar courses. Candidates also are required to include two units in Old French philology, for which some knowledge of Latin is essential. These courses may be counted as a first minor subject. French 406 also is required.

Master of Arts in the Teaching of French. Candidates for the Master of Arts in the Teaching of French must earn four units in French, two units in education, and two units in electives. Requirements are French 311, 313, 314, two units; two of the following courses: History and Philosophy of Education 303, 304, 305, one unit; and Educational Psychology 311 and 312, one unit. The elective courses in French and the other electives must be selected with the approval of the adviser. The electives may be in French, in education, or, in exceptional cases, in other fields, See pages 45 and 46.

GRADUATE FACULTY

Professors: B. H. Mainous (Head of Department), F. Jost, C. A. Knudson, P. Kolb, F. W. Nachtman, C. P. Viens.

Associate Professors: P. E. Barrette, F. Bassan, Barbara C. Bowen, V. E. Bowen, H. C. De Ley, S. E. Gray, E. Jahiel, F. M. Jenkins, M. K. Myers, J. K. Simon.

Assistant Professor: L. B. Price.

COURSES FOR GRADUATES

400. **Beginning French for Graduate Students.** Basic grammar and vocabulary; reading practice. Designed for graduate students desiring help in preparing for the French reading requirements for the Ph.D. No graduate credit.

401. **Reading French for Graduate Students.** Grammar, vocabulary, general and special reading. Designed for graduate students desiring help in preparing for the French reading requirements for the Ph.D. No graduate credit. Prerequisite: French 400, or French 101 and 102, or equivalent.

405. **Teaching College French.** A study of the problems of teaching French at the college level, including classroom procedures and language laboratory techniques. No credit.

406. **Research Methods.** Orientation in graduate research, introduction to bibliographical problems, and survey of methodology for papers and dissertations. ¼ or ½ unit. V. Bowen.

Note: In any given year a selection for the following courses is offered. For current information, consult the department office or the current semester Time Table.

407. **French Literary Criticism, I: History of French Literary Criticism from the**

Sixteenth to the Twentieth Centuries. Literary theory and practice of criticism as developed in France from the sixteenth to the twentieth centuries. Analysis and discussion of preoccupations, critical methods, and approaches to literature of representative critics, with emphasis upon emergence of philosophies of criticism. 1 unit.

408. **French Literary Criticism, II: Studies in Recent French Criticism.** Study of important trends in French literary criticism of the mid-twentieth century, relating these trends to critical problems and theories of literature of the late nineteenth century and the earlier part of the twentieth. 1 unit.

421. **Literature of the French Renaissance.** Discussion and analysis of some of the more important intellectual and religious preoccupations of the sixteenth century, as reflected in representative texts by important writers of the period. 1 unit.

424. **Studies in French Poetry.** Versification, poetic structure, problems of imagery and meaning, and practical work in the interpretation of individual poems. 1 unit. GRAY.

425. **Explication de textes, I.** Exercises according to the method of *explication de textes*, applied to texts selected principally from the period 1944-1958. 1 unit.

426. **Explication de textes, II.** The French method of *explication de textes* applied to selected texts of the principal French writers, in particular the *penseurs et essayistes*. 1 unit.

433. **Villon, Rabelais.** 1 unit. Offered in 1969-1970 and in alternate years. B. BOWEN.

434. **Studies in Montaigne.** A discussion of the most important aspects of Montaigne as a writer, and of his place in French literature. 1 unit.

435. **Seventeenth-Century Literature, I.** 1 unit. Offered in 1969-1970 and in alternate years.

436. **Seventeenth-Century Literature, II.** 1 unit. Offered in 1969-1970 and in alternate years.

437. **Eighteenth-Century Literature, I.** 1 unit. Offered in 1968-1969 and in alternate years. V. BOWEN, JOST.

438. **Eighteenth-Century Literature, II.** 1 unit. Offered in 1968-1969 and in alternate years. V. BOWEN, JOST.

447. **French Romanticism, I.** 1 unit. Offered in 1968-1969 and in alternate years.

448. **French Romanticism, II.** 1 unit. Offered in 1968-1969 and in alternate years.

453. **French Realism and Naturalism, I.** 1 unit. Offered in 1969-1970 and in alternate years.

454. **French Realism and Naturalism, II.** 1 unit. Offered in 1969-1970 and in alternate years.

457. **Seminar in Proust, I.** ½ unit. Offered in 1968-1969 and in alternate years. Prerequisite: French 342 or consent of instructor. KOLB.

458. **Seminar in Proust, II.** ½ unit. Offered in 1968-1969 and in alternate years. Prerequisite: French 342 or consent of instructor. KOLB.

459. **Seminar in Modern French Literature, 1870 to 1935.** An intensive study of one or two authors of the late nineteenth and early twentieth centuries. Authors who may be studied include the Parnassian or Symbolist poets and the following novelists: Barrés, Bourget, Anatole France, Loti, Gide, Martin du Gard, Duhamel, Mauriac, Giraudoux. 1 unit. Students may receive credit more than once.

460. **Seminar in French Literature.** Discussion and research on some specialized

area in French literature. Topic will be announced in advance. Course may be repeated for credit. 1 unit.

462. **Introduction to Romance Linguistics.** See Linguistics 462. ½ unit. Prerequisite: Four semesters of a Romance language or Latin, or equivalent.

463. **La Poésie Symboliste.** An intensive study of two of the following major poets: Nerval, Baudelaire, Rimbaud, Mallarmé. 1 unit.

464. **Du Cubisme au Surrealisme.** A study of the poetic and theoretical writings of Apollinaire, Reverdy, Jacob, Breton, and Eluard. 1 unit.

465. **La Littérature Contemporaine, I.** In French. Twentieth-century poets and novelists. 1 unit. Offered in 1968-1969 and in alternate years. GRAY, SIMON.

466. **La Littérature Contemporaine, II.** 1 unit. Offered in 1968-1969 and in alternate years. GRAY, SIMON.

475. **Introduction to Old French, I.** Training in reading Old French (twelfth and thirteenth centuries), outline of Old French grammar, reading of characteristic works, outlines of literary history. 1 unit. Prerequisite: Consent of instructor.

476. **Introduction to Old French, II.** Training in reading Old French (twelfth and thirteenth centuries), outline of Old French grammar, reading of characteristic works, outlines of literary history. 1 unit. Prerequisite: French 475 or equivalent.

481. **Old Provençal Historical Grammar.** The phonology, morphology, and syntax of the Old Provençal language with emphasis on its Latin origins; illustrative reading of selected prose works. Lectures are in English. 1 unit. Prerequisite: Consent of instructor.

482. **Old Provençal Literature.** Selected readings of various *genres*, emphasizing lyric poetry, with attention to its position in European literature. Lectures are in English. 1 unit. Prerequisite: French 481 or consent of instructor.

483. **Studies in Old French Literature.** Close study of one or more topics in Old French literature. 1 unit. Prerequisite: Consent of instructor.

484. **Historical French Grammar.** A study of the development of the French language, principally Old French from Latin. 1 unit. Prerequisite: French 475; an elementary knowledge of Latin.

491. **Individual Topics.** ¼ to 1 unit. STAFF.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

Note: The prerequisite for all courses in this group is French 201 and 202, or equivalent.

311. **French Diction.** Training in the improvement of French pronunciation, with special attention to the problems of teachers. It is recommended that this course and French 313 be taken concurrently. ½ unit. Prerequisite: Consent of instructor. VIENS.

313. **French Phonetics.** A systematic study of the sounds and sound patterns of French. It is recommended that this course and French 311 be taken simultaneously. ¾ unit. Prerequisite: Consent of instructor. JENKINS, MYERS.

314. **French Syntax.** An advanced theoretical and practical study of present-day French, with some consideration of stylistics. ¾ unit. Prerequisite: French 213 and 214, or equivalent.

315. **Stylistics.** Linguistic analysis of a variety of French prose styles to illustrate the range of expressions for the same or similar ideas. Translation into French of

fairly difficult English prose; occasional directed composition. ¾ unit. Prerequisite: French 314.

316. Structure of the French Language. Same as Linguistics 316. A general survey of the linguistic structure of modern standard French, including phonology, morphology, and syntax. Emphasis on the differences between its spoken and written forms. ¾ unit. Prerequisite: French 313 or equivalent training in phonetics. JENKINS.

335. French Civilization, I. In French. A survey of French life and French institutions, intended as a background for literary studies and as a preparation for the teaching of French. ¾ unit.

336. French Civilization, II. ¾ unit.

342. Lectures de Proust: *A la recherche du temps perdu*. Readings and textual explication in Marcel Proust's novel, *A la recherche du temps perdu*. ¾ unit. Prerequisite: French 201 and 202, or equivalent.

382. Language Laboratory Techniques. Same as German, Slavic, and Spanish 382. Instruction and practice in the techniques of making foreign-language tapes and integrating them with classroom activity; instruction in the problems of planning and operating a language laboratory. ½ unit. Prerequisite: Three years of a modern foreign language at the college level, or equivalent. MYERS.

GENERAL ENGINEERING

The courses listed below may be taken for graduate credit by students whose advisers approve their selection as satisfying part or all of the requirements for a minor for the master's degree.

GRADUATE FACULTY

Professors: J. S. DOBROVOLNY (Head of Department), B. O. LARSON, E. C. McCLINTOCK, J. E. PEARSON.

Associate Professors: R. J. PLACEK, F. L. SPALDING.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

304. Professional Expression. Reading and critical study of significant authors from Plato to W. H. Whyte, selected for their contributions to intellectual breadth, imagination, and perfection of style. Original projects allow coordination with seminar and other content courses, and permit the mature student to gain any needed knowledge of reports, administrative correspondence, and articles for publication. 1 unit. Prerequisite: Consent of instructor. MCCLINTOCK.

313. Advanced Methods in Engineering Graphical Computations. Application of determinants in the theory and construction of engineering nomograms; curve fitting and formulation of empirical formulae; methods and application of graphical calculus. ½ to 1 unit. Prerequisite: Mathematics 142 or equivalent. PLACEK.

330. Industrial Standardization. Evolution and history of standardization; local, national, and international standardization; governmental standardization. Special emphasis is placed on standardization procedures for individual industrial establishments. ½ unit. Prerequisite: Consent of instructor. SPALDING.

334. Introduction to Reliability Engineering. Same as Industrial Engineering 334. An introduction to concepts in engineering design, testing, and management for

highly reliable components and systems. ¾ or 1 unit. Prerequisite: Industrial Engineering 333, or Mathematics 361, or equivalent with consent of instructor.

360. **Engineering Applications of Meteorological Fundamentals.** The application of the fundamentals of meteorology to engineering problems including the transport and diffusion of particulate matter, aerosols, and gases; precipitation processes and rainout; behavior of stack effluents, explosion debris, and radioactive materials in the atmosphere. Applications to operation scheduling and to site selection. 1 unit. Prerequisite: Mathematics 142 or 143; Physics 106, 107, and 108; Mechanical Engineering 205 and 206, or 209, or Chemistry 342 and 344, or Physics 360. PEARSON.

393. **Special Problems.** Study of advanced problems related to general engineering and graphics. ½ to 1 unit. Prerequisite: Consent of instructor. LARSON, STAFF.

GENETICS

A Doctor of Philosophy program in genetics is provided through the cooperative efforts of eight different departments of biology and is administered by the University Committee on Genetics. Training in biochemical genetics, cytogenetics, and population genetics of a variety of organisms is provided. Students seeking master's degrees are directed to the various departmental programs, or to the master's program in biology offered by the School of Life Sciences.

Applicants for admission should have at least a 4.0 grade-point average for the last sixty hours, but may be considered for admission with a 3.75 average. They should also have completed one year of college physics, quantitative and organic chemistry, trigonometry, and analytic geometry. Calculus is strongly recommended. During the first calendar year of graduate study, students are required to take an advisory examination in the major genetic areas.

During the first two years, candidates should complete courses or demonstrate proficiency in biological chemistry (Chemistry 350, 355), calculus (Mathematics 132, 142, or 133, 143), statistics (Mathematics 363 or Agronomy 440), cytology (Botany 420), cytogenetics (Botany 421), population genetics (Animal Science or Dairy Science 411, or Zoology 407), and microbial genetics (Microbiology 330). All programs of study must be approved by the Genetics Committee. Students wishing a sole minor in genetics are required to complete four units of work in areas approved by the Committee and including at least three-fourths unit in a 400-level course outside the major area.

Students majoring in genetics ordinarily elect minors in one of the biology departments and in either chemistry or mathematics. Students in the genetics program are eligible for fellowships and assistantships in the participating departments and should indicate their departmental preference (Agronomy, Animal Science, Botany, Dairy Science, Horticulture, Microbiology, Psychology, or Zoology) when applying for admission.

Thesis research may be carried out under the direction of appropriate staff members in the participating departments under departmental course listings. Inquiries concerning the program should be directed to the Chairman of the Genetics Committee, Professor Denton E. Alexander, S-110 Turner Hall.

GEOGRAPHY

The Department of Geography offers work leading to the Master of Arts, Master of Science, Master of Science in the Teaching of Geography, and Doctor of Philosophy. At the master's level, study programs emphasize research techniques and systematic geography; individual programs for the doctoral candidates stress specialization in

particular fields of systematic and regional geography, work in cognate disciplines, and encouragement of individual research.

Students applying for admission must have a grade-point average of 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis. All candidates for advanced degrees in geography must have an average of at least 4.25 in previous work in geography.

Master of Arts or Master of Science in Geography. Successful candidates for the master's degree whose backgrounds are largely in physical geography are recommended for the Master of Science; others receive the Master of Arts.

At least four of the minimum of eight units of graduate credit required for the master's degree must be in geography, and all eight may be in geography. In individual cases, additional units of work may be required by the departmental graduate committee. Students must have had, either as undergraduates or as graduates, training in climatology, map construction and map reading and interpretation, introductory field work, cultural geography, and regional geography. They must also have proficiency equivalent to that expected of a University of Illinois undergraduate major in a physical or biological science, in a social science, in statistical method, and in oral and written expression. Geology, botany, soils, or zoology are recommended as physical or biological sciences; economics, history, political science, sociology, or anthropology are recommended in the social sciences.

Master of Science in the Teaching of Geography. Candidates for this degree must earn four units in geography, two of which are geography electives, two units in education, and two units in electives. The grade-point average required for admission is 3.5. See pages 45 and 46. The adviser for candidates for this degree is Professor F. W. Foster, 123 Davenport Hall.

Doctor of Philosophy. The doctoral student is expected to penetrate deeply into specific phases of geographic study, including one physical systematic field, one cultural systematic field, and one major region of the world.

Candidates for this degree must have taken, either as undergraduates or as graduates, all work required in the undergraduate major and the master's and doctor's programs of the department or the equivalent.

Admission to candidacy for the Doctor of Philosophy in geography is recommended after the successful completion of:

(1) At least sixteen units of graduate credit, or equivalent, including four units in official minor fields. At least nine of these sixteen units must be in geography. The department recommends a split minor, consisting of at least two units in each field. One of the minors should be in geology, botany, soils, or zoology; the other in anthropology, economics, history, political science, sociology, Latin-American studies, or Russian studies. Other minor fields may be accepted upon recommendation of the major adviser.

(2) The required examinations in foreign languages.

(3) A preliminary examination.

After being admitted to candidacy for the Doctor of Philosophy, the student must complete a research thesis, eight units of Geography 499, which normally requires field investigation.

GRADUATE FACULTY

Professors: J. Thompson (Head of Department), A. W. Booth, J. D. Fellmann, F. W. Foster, J. H. Garland, H. G. Roepke, J. A. Russell, D. B. Shimkin.

Associate Professors: C. S. Alexander, J. F. Lahey

Assistant Professors: J. A. Jakle, P. D. LaValle.

COURSES FOR GRADUATES

412. **Analytical Climatology.** A detailed consideration of the character and causes of the climates of certain selected areas; the application of various criteria as bases for climatic differentiation. 1 unit. Prerequisite: Geography 111; Geography 313 or equivalent; consent of instructor. LAHEY.

421. **Regional Concepts in Geography.** Theories of regionalism, nature of the geographic region, the unique position of regionalism in a total geographic philosophy; regionalism in applied geography. ½ unit. Prerequisite: Nine hours of regional geography. GARLAND.

429. **The Evolution of Agricultural Economies.** Same as Agronomy and Anthropology 429. The problems concerning the development of the several basic food crop economies are studied from the point of view of geographical environment, the available archaeological and ethnographic evidence, and from the point of view of agronomy and plant genetics. The regional emphasis varies from year to year. 1 unit. Prerequisite: Consent of instructor. ALEXANDER, STAFF.

461. **Fundamentals of Bioclimatology.** Same as Physiology 461. The effects of physical factors (such as barometric pressure, temperature, humidity, radiation, and air movement) on physiological processes in mammals; and the application of meteorological, climatological, and geographical techniques in physiological studies. ¾ unit. Prerequisite: Consent of instructor.

462. **Experimental Bioclimatology.** Same as Physiology 462. Laboratory work and demonstrations on methods of measuring meteorological factors, of clinical thermometry, and of partitional calorimetry; laboratory work on physiological adjustments of man to heat, cold, and high altitude. ½ unit. Prerequisite: Physiology 301, or 401 and 402; credit or registration in Geography 461.

463. **Historical Geography.** Objectives and methods of historical geography. 1 unit. JAKLE, RUSSELL.

464. **Advanced Human Bioclimatology.** Same as Physiology 464. Topics in human bioclimatology and medical geography, such as climatic determinism, meteorotropism, the weather elements as stresses, and acclimatization. ½ unit. Prerequisite: Geography 461.

473. **Problems in Cartography.** Subjects for map presentation are selected in the student's field of specialization or area of interest. Data are collected and maps complied and carried to completion in final drafted form suitable for publication. 1 unit. Prerequisite: Geography 373 or consent of instructor. FOSTER.

477. **Area Analysis.** Individual analysis of areas in the vicinity of Urbana. 1 unit. FOSTER.

478. **Advanced Field Geography.** A graduate course in the theory and application of geographical field techniques to the analysis of areas, culminating in individual reports on assigned problems in the field course area. S; 1¼ to 2 units. STAFF.

495. **Advanced Studies in Geography.** Directed and supervised detailed investigation of selected problems or regions. Designed to develop ability to conduct independent investigation. ½ to 2 units. Work may be taken in the following fields:

(a) **Physical Geography, Africa, Agricultural Origins.** ALEXANDER.
(b) **Medical Geography, Australia and New Zealand, Quantitative Geography.** ARMSTRONG.
(c) **Asia, Resource Management, Transporation.** BOOTH.
(d) **Urban Geography, U.S.S.R.** FELLMANN.
(e) **Middle East, Advanced Cartography.** FOSTER.
(f) **Anglo America, Political Geography, Regionalism.** GARLAND.

(g) **Economic Geography, Industrial Location, Europe.** ROEPKE.
(h) **Europe, Marketing Geography.** RUSSELL.
(i) **Human Ecology, U.S.S.R.** SHIMKIN.
(j) **Cultural Geography, Latin America.** THOMPSON.
(k) **Climatology, Meteorology.** LAHEY.
(l) **Geomorphology, Soils, Quantitative Methods.** LAVALLE.
(m) **Historical, Cultural, Population Geography.** JAKLE.

497. **Development of Geographic Thought.** A consideration of the various philosophies of geography and of the men who reflect them. ½ unit. FELLMANN.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

306. **Maps and Cartobibliographical Aids.** An examination of the problems involved in the acquisitions, care, and library use of maps. Classes become familiar with the major cartobibliographical and related aids. ½ unit. Prerequisite: Consent of instructor. WHITE.

313. **Climates of the Continents.** A regional treatment of the climates of the world by continents. ¾ unit. Prerequisite: Geography 101 and 111. LAHEY.

314. **Regional Problems in Conservation of Natural Resources.** The distribution, use, and interrelationship of the resources in the various resource management regions of the United States, the conservation techniques applied to them, and the problems of public policy in their effective management. ¾ unit. Prerequisite: A previous course in conservation, or workshop or field work training in conservation. BOOTH.

323. **Geography of the North American Midwest.** The core of the North American continent; detailed analysis of the functions and patterns of the Midlands and their external relations. ¾ unit. Prerequisite: Eight hours of geography or consent of instructor. GARLAND.

332. **Geography of South America.** A regional geography of South America with emphasis on the southern hemisphere of that continent. ¾ unit. Prerequisite: Eight hours of geography or enrollment in Latin-American studies program, or consent of instructor. THOMPSON.

342. **Geography of Europe.** Influence of climate, surface features, and natural resources on the distribution of the people, their industries, and routes of trade; new boundaries and present economic problems in their geographic setting. ¾ unit. Prerequisite: Eight hours of geography or consent of instructor. RUSSELL.

351. **Geography of Asia.** A regional geography of Asia with concentration on the monsoon realm of southern and eastern Asia. ¾ unit. Prerequisite: Eight hours of geography or consent of instructor. BOOTH.

353. **Geography of the U.S.S.R.** Physical and cultural regionalism; a survey of natural resources and patterns of human occupance including industry, agriculture and transportation. ¾ unit. Prerequisite: Eight hours of geography, consent of instructor, or enrollment as a major or minor in Russian language and area studies. FELLMANN.

355. **Geography of Central and South Africa.** A regional geography of Africa south of the Sahara. ¾ unit. Prerequisite: Eight hours of geography or consent of instructor. ALEXANDER.

357. **Geography of the Middle East and North Africa.** A regional geography of an area with limits largely defined in terms of Arab and Moslem influences or closely related cultural and historical circumstances. The course is oriented around the

strategic centrality of the core of the territory as the crossroads of Europe, Asia, and Africa. ¾ unit. Prerequisite: Eight hours of geography or consent of instructor. FOSTER.

361. **Geography of Agricultural Land Utilization.** A geographic consideration of the nature of agricultural land utilization from the world, continental, and regional viewpoints. Special emphasis is on the geographical implications of various types of agricultural land use and upon the interrelationships between areas of different types of land utilization. ¾ unit. FOSTER.

362. **Geography of Manufacturing.** An analysis of the factors bringing about geographical concentration of industry. Each of the major manufacturing regions of the world is described and analyzed in terms of the geographic conditions which have influenced its location and products. ¾ unit. Offered in 1968-1969 and in alternate years. ROEPKE.

363. **Geography of Minerals.** Geographic aspects of the mineral industries. ¾ unit. Offered in 1969-1970 and in alternate years. ROEPKE.

365. **Geography of Transportation.** A consideration of the agents of transportation (land, water, air), the routes of transportation, transportation terminal complexes, and the basic commodity exchange services of transportation within the framework of their regional interregional relationships. ¾ unit. BOOTH.

366. **Location of Industry and Other Economic Activities: Theory and Practice.** Locational theory applied to the relationship between geographic facts of relief, climate, resources, population, and transportation and the industrial location process; case studies in the effects of transportation networks and rates, sources of materials, labor supply, location of markets, etc., on the selection and evaluation of industrial sites; study of factors affecting location of stores and other commercial activities. ¾ unit. FELLMANN, ROEPKE.

369. **Introduction to Human Ecology.** Same as Anthropology, Health Education, Physiology, Sociology, Veterinary Medical Science, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations and physiological, psychological, and sociological adjustments to environment, regulation of population, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology; one year of anthropology, geography, geology, or sociology. SHIMKIN, STAFF.

370. **Quantitative Methods in Geography.** Geographical applications of statistical and mathematical research techniques. ¾ unit. Prerequisite: Geography 185, or one year of college mathematics, or one course in statistics, or the equivalent. LAHEY, LAVALLE.

371. **Introduction to Research.** Introductory training in bibliographical and cartographic techniques as source materials of geographic research. Limited to students whose major is geography and to seniors whose major is in other departments but who have twelve hours of geography. ¾ unit. FELLMANN, STAFF.

372. **Introduction to Research.** Continuation of Geography 371. The employment of a range of geographic techniques and sources leading to completion of individual papers. ½ unit. JAKLE.

373. **Map Compilation and Construction.** Laboratory instruction and practice in the basic techniques of map making, followed by a consideration of problems involved in the construction of maps for presentation in a reproduced form (i.e., printed, photographed). Included are the selection of proper source materials for the base and body of the map, the compilation and correlation of these materials, and methods of mechanical and photographic reproduction. 1 unit. Prerequisite: Consent of instructor. FOSTER.

374. **Problems in Human Ecology.** Same as Anthropology, Health Education, Physiology, Psychology, Sociology, and Veterinary Medical Science 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multidisciplinary studies of selected current problems. 1 unit. Prerequisite: Geography, Anthropology, Health Education, Physiology, Sociology, or Zoology 369. ALEXANDER, SHIMKIN.

378. **Descriptive Interpretation of Remote Sensors.** Descriptive interpretation of remote-sensing images with emphasis on interpretation of aerial photography; applications of aerial photography and photographic interpretation to the solution of problems in the major field of the individual student. Two half-day field trips on Saturdays are required. 1 unit. Prerequisite: Consent of instructor. BOOTH.

381. **Russian Culture History and Ethnology.** Same as Anthropology 381. A historical and structural analysis of the development of Russian culture, especially the peasant traditions from Danubian to contemporary times. ½ or 1 unit. SHIMKIN.

382. **Siberian Culture History and Ethnology.** Same as Anthropology 382. An ecological analysis of historic and present-day Siberian cultures, with comparisons to Arctic America. ½ or 1 unit. SHIMKIN.

383. **Urban Geography.** The distribution, functions, and internal structure of cities; a geographic analysis and classification of urban centers and their tributary areas. ¾ unit. FELLMANN.

386. **Political Geography.** World patterns of nations in relation to their natural environmental backgrounds: European nations; Africa, the exploited continent; national structures in Asia; Western Hemisphere nations. ¾ unit. GARLAND.

GEOLOGY

Graduate students may take work in the Department of Geology leading to the Master of Science and Doctor of Philosophy. Candidates for the master's degree are advised to plan their work to secure a firm foundation in geology, mathematics, and in chemistry, physics, or biology rather than to specialize too narrowly. Candidates for the doctor's degree may work in the special fields of clay mineralogy, geochemistry, geomorphology and glacial geology, mineral deposits, mineralogy and petrology, oceanography, paleontology and stratigraphy, ground-water geology, sedimentation, sedimentary petrography, structural geology, and submarine geology.

Admission requires a minimum grade-point average of 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

For graduate work in geology a student must have had (or take as a graduate student) undergraduate courses in physical geology, historical geology, mineralogy, geomorphology, structural geology, paleontology, stratigraphy, summer field course, chemistry, physics, and mathematics. He may substitute advanced courses in mathematics, chemistry, physics, or the biological sciences for certain geology courses with departmental approval.

A candidate for the doctor's degree may select a minor in chemistry, physics, mathematics, mining or civil engineering, zoology, botany, agronomy, or geography. Other minors may be chosen with departmental approval.

Master of Science in the Teaching of Earth Science. Candidates for the Master of Science in the Teaching of Earth Science must earn four units in geology; two units in other earth science areas; and two units in education including History and Philosophy of Education 304 and 305 and Educational Psychology 311 and 312.

GRADUATE FACULTY

Professors: F. A. Donath (Head of Department), A. Carozzi, C. A. Chapman, C. W. Collinson, D. U. Deere, J. C. Frye, A. F. Hagner, R. L. Langenheim, P. R. Shaffer, G. W. White.

Associate Professors: W. W. Hay, D. M. Henderson, A. F. Richards, F. M. Wahl.

Assistant Professors: D. E. Anderson, D. B. Blake, C. J. Mann, P. A. Sandberg.

COURSES FOR GRADUATES

401. **Advanced Dynamic Geology.** A study of geologic processes and their effects. 1 unit.

402. **Advanced Historical Geology.** Principles of interpretation and problems of earth history. 1 unit.

409. **Sedimentation.** 1 unit.

415. **Regional Field Geology.** Field study of critical localities within a geologic province during a period of two or three weeks; discussion of observations and preparation of reports in which the concepts and principles mastered in graduate study are applied to regional geologic synthesis. 1 unit. Prerequisite: Consent of instructor. Langenheim.

420. **Paleoecology.** Interpretation of life habit of fossil organisms from skeletal morphology and associated depositional features; reconstruction of marine ecosystem relations from the study of assemblages of fossils. 1 unit. Prerequisite: Geology 320 or equivalent. Hay.

421. **Advanced Invertebrate Paleontology.** Intensive study of a selected invertebrate group. 1 unit. Prerequisite: Geology or Zoology 320.

422. **Stratigraphic Geology: Paleozoic.** The concept of the Paleozoic Era and its periods, series, stages, and zones; evaluation of the type sequences and the succession of faunas; problems of correlation and historical inference. 1 unit. Prerequisite: Geology 321 and 322. Langenheim.

423. **Stratigraphic Geology: Mesozoic.** The concept of the Mesozoic Era and its periods, series, stages, and zones; evaluation of the type sequences and the succession of faunas; problems of correlation and historical inference. 1 unit. Prerequisite: Geology 321 and 322. Langenheim.

424. **Stratigraphic Geology: Cenozoic.** The concept of the Cenozoic Era and its periods, series, stages, and zones; evaluation of the type sequences and the succession of faunas; problems of correlation and historical inference. 1 unit. Prerequisite: Geology 321 and 322.

425. **Micropaleontology: Benthonic Foraminifera.** Classification, biology, and distribution in time and space of benthonic foraminifera; emphasis on ecology and evolution. 1 unit. Prerequisite: Geology or Zoology 320 or Zoology 318.

426. **Micropaleontology: Ostracoda.** Morphology, classification, ontogeny, and phylogeny of fossil and living Ostracoda; study of stratigraphic, paleoecologic, and ecologic distribution, and of soft part morphology. 1 unit. Prerequisite: Geology or Zoology 320.

427. **Micropaleontology: Conodonts.** Morphology and history of conodonts, chitinozoans, and lesser groups with emphasis on use in biostratigraphy and paleogeography. 1 unit. Prerequisite: Geology or Zoology 320; consent of instructor.

428. **Micropaleontology: Plankton.** Classification and distribution of major groups of shelled oceanic plankton: foraminifera, radiolaria, coccolithophores, diatoms,

and others; emphasis is on biostratigraphic use of these fossils. 1 unit. Prerequisite: Geology or Zoology 320 or Zoology 318; consent of instructor.

430. Crystallography. A consideration of the approaches and techniques required for an understanding of the structures and properties of crystals, especially those of minerals; emphasis is given to the development of pattern theory, space groups, and their applications. 1 unit. Prerequisite: Geology 335 or equivalent; consent of instructor. HENDERSON.

431. Structural Mineralogy. Principles of the crystal chemistry and structural classification of minerals, and survey of the current knowledge about the structures and structurally dependent properties and behavior of representative minerals and mineral groups. 1 unit. Prerequisite: Geology 430; consent of instructor. HENDERSON.

432. Geochemistry. A chemical approach to the interpretation of geological processes with emphasis on principles which control the distribution and migration of elements in geological environments. 1 unit. Prerequisite: Geology 336 or Chemistry 321, or equivalent; consent of instructor. WAHL.

435. Igneous Petrology. The origin and history of igneous rocks. Application of chemistry and physics to igneous petrology. In the laboratory a study is made of selected rock suites, and special methods of petrographical investigation are covered. 1 unit. CHAPMAN.

436. Metamorphic Petrology. Problems in metamorphism and advanced studies of metamorphic rocks. In the laboratory, selected rock suites are studied, and special methods of investigation are covered. 1 unit. ANDERSON.

437. Sedimentary Petrology. A study of sedimentary petrogenesis, including erosion, transportation, deposition, consolidation, diagenesis, and lithification. 1 unit. Prerequisite: Geology 335. RICHARDS.

438. Sedimentary Petrography. Microscopic study of sedimentary rocks in thin section with emphasis on textures and structures as a basis for their detailed classification and genetic interpretation. 1 unit. Prerequisite: Geology 335 and 437. CAROZZI.

440. Mineragraphy. Microscopic study of ore minerals including methods of identification, textures, structures, and paragenesis. 1 unit. HAGNER.

443. Mineral Deposits. Principles of mineral desposition and genesis of mineral deposits. 1 unit. Prerequisite: Geology 311. HAGNER.

444. Mineral Deposits. Structural control of mineral deposition and a study of the principal types of mineral deposits. Laboratory study of structures and of types of deposits. 1 unit. Prerequisite: Geology 443. HAGNER.

450. Geology for Civil Engineers. Advanced physical geology, with emphasis on the geological aspects of civil engineering. 1 unit. Prerequisite: Geology 150 or equivalent. DEERE.

455. Hydrogeology. The geology of the occurrence, storage, movement, and quality of water in the rocks of the Earth's crust. 1 unit. Prerequisite: Consent of instructor.

461. Mineralogy of Clays. Same as Ceramic Engineering 461. The composition of various types of clays; the structure and properties of the clay minerals; the origin and mode of occurrence of the clay minerals and clay materials. 1 unit. Prerequisite: Geology 336 or equivalent; consent of instructor. WAHL.

462. Mineralogy of Clays. Same as Ceramic Engineering 462. The properties of clay materials, their relation to the structure of the clay minerals, methods of determination and control; the utilization of clays in various arts and industries. 1 unit. Prerequisite: Geology 461.

471. **Submarine Geology.** General geology of the ocean basins and continental margins, with emphasis on the geological interpretation of marine geophysical investigations. 1 unit. Prerequisite: One year of physics or consent of instructor. RICHARDS.

477. **Marine Geotechnique.** Origin and distribution of deep-sea sediments, theory and methods of sampling, mass physical and chemical properties, structural changes caused by organisms, influence of sheer strength, and consolidation on diagenesis. ½ or 1 unit. Prerequisite: Geology 437 or consent of instructor.

479. **Statistical Geology.** Analysis of the geologic assumptions necessary to fulfill mathematical requirements in numerical analysis of geologic problems. 1 unit. Prerequisite: Mathematics 161 or Agronomy 240; Computer Science 101; consent of instructor.

493. **Advanced Studies in Geology.** ½ to 2 units. Work may be taken in the following fields:

(a) **Clay Mineralogy.** WAHL.
(b) **Engineering Geology.** DEERE, RICHARDS.
(c) **Geomorphology and Glacial Geology.** SHAFFER, WHITE.
(d) **Geotectonics.** CAROZZI.
(e) **Ground-Water Geology.**
(f) **Micropaleontology.** COLLINSON, HAY, SANDBERG.
(g) **Mineral Deposits.** HAGNER.
(h) **Mineralogy and Crystallography.** HENDERSON.
(i) **Paleontology.** BLAKE, HAY, LANGENHEIM.
(j) **Geochemistry.** ANDERSON.
(k) **Geophysics.** DONATH.
(l) **Petrography and Petrology.** CHAPMAN.
(m) **Sedimentology.** CAROZZI, RICHARDS.
(n) **Stratigraphy.** LANGENHEIM, MANN.
(o) **Oceanography and Ocean Engineering.** RICHARDS.
(p) **Submarine Geology.** RICHARDS.
(q) **Structural Geology.** DONATH.

499. **Thesis Research.** Individual work under supervision of members of the staff in their respective fields. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Geomorphology.** The study of the history, origin, and characteristics of land forms produced by fluvial, glacial, wind, and wave erosion, or by a combination of these, acting upon the major kinds of geologic materials and structures. Lectures, laboratory, and field trips. 1 unit. Prerequisite: Geology 102. SHAFFER, WHITE.

311. **Structural Geology.** Rock deformation and its results. Lectures, laboratory, and one two-day field trip. 1 unit. Prerequisite: Geology 102; General Engineering 205 or consent of instructor.

315. **Field Methods.** Mapping of an area in southern Illinois or western Kentucky during Easter vacation. Credit is given only on completion of a satisfactory written report. ½ unit. Prerequisite: Geology 102.

320. **Invertebrate Paleontology.** Fossil groups in biological sequence. Lectures and laboratory. A student may not receive credit for both Geology 222 and 320. 1 unit. Prerequisite: Geology 102. HAY.

321. **Stratigraphy.** Stratigraphy-fossil faunas, with special reference to invertebrates, correlation, and stratigraphy. A student may not receive credit for both Geology 222 and 321. 1 unit. Prerequisite: Geology 320.

324. Vertebrate Paleontology. Same as Zoology 324. Phylogeny, morphology, and ecology of the fossil vertebrates. Lecture, laboratory, and field trips. ½ unit. Offered in 1968-1969 and in alternate years. Prerequisite: Geology 102 or Zoology 132. BADER.

325. Paleobotany. Same as Botany 325. The structure, phylogeny, and geological distribution of representative fossil plants. Two or three field trips. 1 unit. Prerequisite: Botany 100 or Division of General Studies 131 and 132, and Geology 101; or consent of instructor.

335. Optical Mineralogy. Study of the optical properties of minerals and the use of the petrographic microscope. Emphasis is placed on the identification of minerals by the immersion method. Designed for students in geology, ceramics, chemistry, mining, and agriculture. 1 unit. Prerequisite: Geology 132. CHAPMAN.

336. Petrography. Study of the constituents, composition, textures, structures, and classification of rocks. In the laboratory, rocks are studied in hand specimen and thin section. Emphasis is placed on the ordinary methods of petrographical investigation. 1 unit. Prerequisite: Geology 335. CHAPMAN.

350. Theoretical Geophysics. An introduction to the major fields of theoretical geophysics: figure of the earth, thermodynamics of the earth, gravity, seismology, magnetism, and planetary geophysics. 1 unit. Prerequisite: Mathematics through calculus; one year of physics; Geology 311; consent of instructor.

351. Geophysical Prospecting. Same as Mining Engineering 351. Principles of geophysics and their application to mining processes. ¾ or 1 unit. Prerequisite: Consent of instructor. DE WITTE.

370. Oceanography. Principles of biological, chemical, geological, and physical marine science. 1 unit. Prerequisite: Botany 100 or Zoology 104, Chemistry 101, Geology 101, Physics 101; or consent of instructor. RICHARDS.

GERMANIC LANGUAGES AND LITERATURES

(Including German, Germanic, and Scandinavian)

The Department of Germanic Languages and Literatures offers work leading to the Master of Arts and Doctor of Philosophy. Students applying for admission must have a 4.0 grade-point average. Applications of students with grade-point averages below 4.0 but above 3.5 are considered on an individual basis. Students should have completed a four-year course of undergraduate study in German corresponding to that of this University. They should be familiar with the principal works of German literature and be able to follow lectures in the German language. Acquaintance with German history, philosophy, and art in their relation to the general European background is desirable.

Requirements for the Master of Arts and for the Master of Arts in the Teaching of German are detailed in pamphlets which may be obtained from the departmental office.

Fields of concentration for the Ph.D. degree are Germanic linguistics, older German literature, modern German literature, and Scandinavian languages and literature.

GRADUATE FACULTY

Professors: H. G. HAILE (Head of Department), J. R. FREY, P. M. MITCHELL, H. STEGEMEIER.

Associate Professors: E. ANTONSEN, H. KNUST, RUTH E. LORBE, F. J. NOCK.

Assistant Professors: J. MCGLATHERY, R. D. SCHIER, H. J. SCHLÜTTER, PAULINE S. SCHWALBE.

German

COURSES FOR GRADUATES

400. **Beginning German for Graduate Students.** Introduction to the reading of German texts in the sciences and the humanities. No graduate credit. SCHWALBE.

401. **Readings in German for Graduate Students.** Designed for graduate students preparing for the German reading requirements for the Ph.D. No graduate credit. Prerequisite: German 400 or equivalent. SCHWALBE.

411. **Proseminar.** Methods of literary criticism and research. 1 unit. MITCHELL.

412. **Proseminar.** Methods in German language study. 1 unit. Prerequisite: German 365 or equivalent. ANTONSEN.

415. **Middle High German.** 1 unit. NOCK.

416. **Middle High German Literature.** 1 unit. Prerequisite: German 415 or equivalent. NOCK.

420. **History of the German Language.** 1 unit. ANTONSEN.

431. **German Literature of the Middle Ages.** German literature from 800 to 1400. 1 unit. Offered in 1969-1970 and in alternate years.

432. **German Literature from 1400 to 1700.** Renaissance, Reformation, and Baroque in German literature. Lectures and readings. 1 unit. Offered in 1969-1970 and in alternate years. STEGEMEIER.

441. **German Romanticism.** 1 unit. Offered in 1969-1970 and in alternate years. MCGLATHERY.

442. **Nineteenth-Century German Realism.** 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: German 301 and 302 or equivalent.

445. **Old High German.** Grammar and interpretation of the oldest literary documents. 1 unit. Offered in 1968-1969 and in alternate years.

451. **Naturalism, Symbolism, Expressionism.** German literature from the 1880's to the 1920's. 1 unit. Offered in 1968-1969 and in alternate years.

452. **German Literature from the Twenties to the Present.** 1 unit. Offered in 1968-1969 and in alternate years. Prerequisite: German 301 and 302, or equivalent.

460. **Seminar in Older German Literature.** 1 unit. Prerequisite: German 411 and 495. STAFF.

461. **Seminar in Modern German Literature.** 1 unit. Prerequisite: German 411 and 495. STAFF.

493. **Research in Special Topics.** ¼ to 2 units; may be repeated for a maximum of 2 units.

495. **Bibliography and Methods of Literary History.** To be taken concurrently with German 411. ½ unit. FREY.

499. **Thesis Research.** 0 to 4 units. ANTONSEN, FREY, HAILE, MITCHELL, STEGEMEIER.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **German Literature to 1700.** ¾ unit. Prerequisite: German 210 and one other course in German literature. STEGEMEIER.

302. **German Literature Since 1700.** ¾ unit. Prerequisite: German 210 and one other course in German literature. MCGLATHERY.

303. **Advanced Conversation, Composition, and Syntax.** Extensive study of ad-

vanced problems of grammar, syntax, and style. ½ unit. Prerequisite: Three years of college German including German 212, or consent of instructor.

304. **Advanced Conversation.** Practice in free conversation with native speaker. No graduate credit. Prerequisite: German 303 or equivalent.

305. **Modern German Poetry.** A political and metrical survey of modern German lyric verse. ¾ unit. Prerequisite: German 210 and one other literature course or its equivalent, or consent of instructor. LORBE.

307. **The Structure of the German Language.** Study of the structure of the German language with emphasis on contrastive syntax of English and German. ¾ unit. Prerequisite: German 210 and 212. NOCK.

311. **Goethe.** Introduction to Goethe's life and works. ¾ unit. Offered in 1968-1969 and in alternate years. Prerequisite: German 210 and one other course in German literature. MITCHELL.

312. **Goethe's Faust.** Intensive study of Goethe's *Faust*, Parts I and II. ¾ unit. Offered in 1968-1969 and in alternate years. Prerequisite: German 210 and one other course in German literature. HAILE.

320. **History of German Civilization.** A selected topical, historical, and pictorial analysis of German culture and civilization. ¾ unit. Prerequisite: German 210 and one other course in German literature. STEGEMEIER.

331. **The Age of Lessing.** ¾ unit. Offered in 1969-1970 and in alternate years. Prerequisite: German 210 and one other course in German literature. SCHWALBE.

332. **Schiller.** ¾ unit. Offered in 1969-1970 and in alternate years. Prerequisite: German 210 and one other course in German literature. FREY.

360. **Introduction to German Phonetics.** ½ unit. Prerequisite: Consent of instructor. NOCK.

382. **Language Laboratory Techniques.** Same as French, Russian, and Spanish 382. Instruction and practice in the techniques of making foreign-languages tapes and integrating them with classroom activity; instruction in the problems of planning and operating a language laboratory. ½ unit. Prerequisite: Three years of a modern foreign language at the college level, or equivalent. NACHTMANN.

392. **Topics in German Literature.** Intensive study of individual authors or other restricted topics in German literature. 1 unit. Prerequisite: Two advanced courses in German literature.

Germanic

COURSES FOR GRADUATES

426. **Gothic.** An introduction to Germanic (comparative) linguistics. 1 unit. Offered in 1969-1970 and in alternate years. ANTONSEN.

462. **Seminar in Germanic Philology and Linguistics.** Problems in diachronic and descriptive Germanic linguistics. 1 unit. Prerequisite: German 411 and 495 or consent of instructor. ANTONSEN.

465. **Comparative Germanic Phonology and Morphology.** The reconstruction of the phonological and morphological systems of Proto-Germanic and their development into the Germanic languages and dialects. 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Germanic 426 or consent of instructor. ANTONSEN.

467. **Runology.** A detailed analysis of inscriptions in the "older" Germanic futhark, the Anglo-Frisian futhorc, and the Scandinavian "younger" futharks; their

relationships and the correlation between phonological and orthographic developments. 1 unit. Offered in 1968-1969 and in alternate years. Prerequisite: Germanic 465 or consent of instructor. ANTONSEN.

Scandinavian

COURSES FOR GRADUATES

405. **Old Norse-Icelandic, I.** Grammar and selected readings. 1 unit. Offered in 1969-1970 and in alternate years. MITCHELL.

406. **Old Norse-Icelandic, II.** Readings. Selections from the Elder Edda and the sagas. 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Scandinavian 405. MITCHELL.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

361. **Ibsen.** The dramas in English translation; selected works of Ibsen's Scandinavian contemporaries. 1 unit. Offered in 1969-1970 and in alternate years. MITCHELL.

362. **Strindberg and the Later Scandinavian Dramatists.** Major dramas and prose works of August Strindberg in translation; selected plays by Kaj Munk, Kjeld Abell, Nordahl Grieg, and Pär Lagerkvist. 1 unit. Offered in 1968-1969 and in alternate years. MITCHELL.

GOVERNMENT AND PUBLIC AFFAIRS

The Institute of Government and Public Affairs renders advisory, consulting, and research services to the governments of Illinois and their elected and appointed officials. Using the data acquired in these activities, the staff seeks, through scholarly and popular publication, to advance knowledge about the science of government and the political process.

HEALTH AND SAFETY EDUCATION

The Department of Health and Safety Education offers a program of study leading to the Master of Science in Health Education. (For information regarding the degree of Doctor of Philosophy in Physical Education with specialization in health education, see page 315.) This program is centered in preparing teachers, administrators, and research workers in the general field of school health education, but also offers opportunities for preparation in the special fields of community health education and safety education.

Admission requirements for a major in this field are: (1) a grade-point average of 3.75 (although applications of students with averages below 3.75 but above 3.5 may be considered on an individual basis); (2) thirty semester hours of approved undergraduate credit in health education or closely related courses; (3) twenty-four semester hours of approved undergraduate credit in science; (4) sixteen semester hours of credit in education; and (5) a course in statistics or measurement.

Requirements for the master's degree are eight units to include: (1) four units in health education or approved courses in physical education; (2) two units in education: History and Philosophy of Education 304 and 305, and Educational Psychology 311 and 312; (3) satisfactory completion of Health Education 490, no credit; (4) presentation of an acceptable thesis in health education, two units. Candidates may petition to waive the thesis and seminar requirements but will be required to take

two units' credit in lieu of thesis credit and, in addition, to pass a final comprehensive written examination in health education. See pages 45 and 46.

GRADUATE FACULTY

Professors: H. S. Hoyman (Head of Department), W. H. Creswell, Jr., A. E. Florio, W. J. Huffman, D. B. Stone.

Lecturers: C. A. Bridger, E. L. Wittenborn, Jr.

Health Education

COURSES FOR GRADUATES

400. **Scientific Foundations of Health Education.** Designed to reinforce and extend the student's knowledge of pertinent scientific health facts and principles as these apply to the further improvement of personal, family, and community health. 1 unit. Prerequisite: Undergraduate courses beyond the elementary level in the biological and physical sciences and in health education. Hoyman.

401. **Problems in School Health Education.** History, philosophy, principles, and practices of school health education in its three main phases: health service, healthful school environment, and health instruction, including evaluation. 1 unit. Creswell, Hoyman, Huffman.

403. **Problems in Public Health.** Deals with the basic facts and principles of public health at the local, state, and national levels, including the relationships between public health departments, voluntary health agencies, and the school health program. ½ or 1 unit. Patterson, Stone.

404. **Trends and Issues in Sex Education.** A critical analysis of current trends and basic issues of sex education; study of present status of sex education in the United States and selected foreign countries; a critical analysis of philosophy, principles, methods, and current problems. 1 unit. Prerequisite: Undergraduate courses beyond the elementary level in the biological and social sciences, or consent of instructor. Hoyman, Huffman.

490. **Seminar.** Student presentation of thesis reports in health and safety education; informal discussions, lectures, and critical analysis of current problems in health and safety education. No credit. Prerequisite: Health Education 495. Staff.

493. **Special Projects.** Independent research. Open only to candidates for the Doctor of Philosophy. ½ or 1 unit. Prerequisite: Educational Psychology 390, Physical Education 495, and Health Education 400, or equivalent. Staff.

495. **Research Methods in Health and Safety Education.** Special emphasis on research orientation and methods; experimental design; processing and analysis of data; selection of research problems and preparation of thesis; current research literature in health and safety education. ½ unit. Prerequisite: Educational Psychology 390 or equivalent.

499. **Thesis Research.** Preparation of theses in health and safety education. ½ to 2 units. Prerequisite: Health Education 495. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

369. **Introduction to Human Ecology.** Same as Anthropology, Geography, Physiology, Sociology, Veterinary Medical Science, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations and physiological, psychological, and sociological adjustments to environment, regulation of population.

and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology; one year of anthropology, geography, geology, or sociology. SHIMKIN, STAFF.

374. **Problems in Human Ecology.** Same as Anthropology, Geography, Physiology, Psychology, Sociology, and Veterinary Medical Science 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multidisciplinary studies of selected current problems. 1 unit. Prerequisite: Anthropology, Geography, Health Education, Physiology, Sociology, or Zoology 369. HOYMAN, LEVINE, STAFF.

390. **Public Health Education.** Theory and practice of community health education; adult health education through media such as radio, television, films, slides, posters, pamphlets, and newspapers; projects in preparing and using public health education materials; evaluation of research in public health education. ½ unit. Prerequisite: Consent of instructor. PATTERSON, STONE.

391. **Public Health Statistics.** An introduction to public health statistics including collection and classification of data; rates and other indices; measures of central tendency and dispersion; tests of significance; use of vital statistics in planning, conducting, and evaluating public and school health education programs. ½ unit. Prerequisite: Mathematics 161 or Educational Psychology 390, or equivalent. BRIDGER.

392. **Health and Safety Education in the Elementary School.** An overview of the school health program designed to acquaint the teacher with modern concepts of health and safety education in the elementary school; consideration is given to the role of the classroom teacher in understanding and meeting the health needs of children; the course focuses on the legal requirements for Illinois schools, major health and safety problems of elementary children, the teacher's role in the school health program, and methods and materials in teaching modern health and safety education. ½ unit. Prerequisite: One year of biological science.

Safety Education

COURSES FOR GRADUATES

402. **Problems in Safety Education.** Philosophy of safety: traffic, recreation, home, and industrial safety facts and figures; the safety problem and its relation to education; organization of safety education programs; methods of teaching; legal aspects; research problems. 1 unit. FLORIO, HUFFMAN.

HISTORY

The Department of History offers work leading to the Master of Arts and Doctor of Philosophy degrees. Graduate work in history presupposes two years of undergraduate study in this subject, or a minimum of sixteen semester hours, including courses in European and American history. Undergraduate linguistic preparation, especially in French, German, or Russian, is important. For ancient, medieval, and renaissance history, some knowledge of Greek or Latin is essential. Spanish is useful for certain fields of European, American, and Latin-American history.

Admission to graduate study in history requires a grade-point average of at least 4.0 for the last sixty hours of undergraduate study. A student who has done graduate work in a recognized institution but without receiving a degree may petition to receive credit toward an advanced degree by passing examinations in this work.

Results of the Graduate Record Examination Aptitude Test should accompany applications for admission to the Graduate College. Information concerning the dates

and places for taking this examination may be secured by writing to the Educational Testing Service, Box 955, Nassau Street, Princeton, New Jersey 08540.

Master of Arts. Candidates are expected to take at least two units in two of the fields of specialization for the Doctor of Philosophy listed below. A minimum of eight units is required for the Master of Arts and three of these units must be at the 400 level. The program must include two research seminars with grades of B or better. Students may elect to write a master's thesis, but the thesis does not replace the seminar requirement. A candidate must demonstrate ability to read one foreign language related to his fields of interest as approved by the graduate advisers.

Graduate study in history may also be pursued in connection with the Master of Arts in the Social Sciences and Master of Arts in the Teaching of Social Studies (see pages 352 and 353).

Doctor of Philosophy. The Department of History offers the following fields of specialization and preparation: ancient Greece; ancient Rome; medieval to 1300; Europe, 1300-1648 (Renaissance and Reformation); Europe and dependencies, 1648-1815; Europe and dependencies since 1815; Russia; England to 1688; England and the Empire-Commonwealth since 1688; Near East and Middle East; China; Japan; South Asia; early America to 1789; United States since 1789; Latin America; History of Science; East Central Europe or Southeast Europe.

A candidate must demonstrate ability to read two foreign languages related to his fields of interest as approved by the graduate advisers. A student who has not completed the requirement in one language will not be readmitted to a second year of graduate study. No student is recommended for financial aid of any kind for a third year of study who has not fulfilled both language requirements.

Two research seminars are normally required for all candidates if these were not taken here in the master's program. History 496 and 498 also are required. The doctorate requires a minimum of sixteen units beyond the master's degree. Eight of these may be thesis research credit.

Candidates shall offer three fields in history, no more than two in the same area, for their preliminary examination. Although an adviser may require work in departments or areas other than history, such work need not be part of the preliminary examinations. A manual for graduate students in history is available from the department.

Doctoral candidates interested in specializing in American culture may elect a major in American history with a first minor, three units, in American literature, and a second minor, two units, in the history of fine arts in the United States.

Illinois Historical Survey. Graduate students have an opportunity to pursue research in connection with the Illinois Historical Survey, an organization carrying on systematic studies in the history of the Midwest. Through the use of materials collected by this survey, students in history are able to obtain useful training in the study of manuscript as well as printed materials.

GRADUATE FACULTY

Professors: C. C. Spence (Chairman of Department), J. L. Bates, C. E. Dawn, R. T. Fisher, Jr., R. W. Johannsen, J. A. Nichols, C. E. Nowell, P. W. Schroeder, W. U. Solberg, C. G. Starr, R. P. Stearns, R. M. Sutton.

Associate Professors: R. B. Crawford, B. D. Hill, K. A. Hitchins, B. B. Kling, R. M. McColley, J. B. Sirich, R. W. Waller.

Assistant Professors: T. A. Krueger, J. L. Love, R. E. Mitchell.

COURSES FOR GRADUATES

403. Problems in Early Modern European History to 1815. 1 unit. Staff.

404. **Problems in Modern European History Since 1815.** 1 unit. STAFF.

407. **Problems in American History to 1865.** 1 unit. STAFF.

408. **Problems in American History Since 1865.** 1 unit. STAFF.

409. **Problems in Asian History.** 1 unit.

411. **Seminar in Ancient History: Greece.** 1 unit. MITCHELL, STARR.

413. **Seminar in Ancient History: Rome.** 1 unit. MITCHELL, STARR.

415. **Seminar in Medieval History.** 1 unit. QUELLER.

417. **Seminar in Renaissance and Reformation History.** 1 unit.

419. **Seminar in European History, 1648 to 1815.** 1 unit. SIRICH.

421. **Seminar in European History Since 1815.** 1 unit. FRANK, MCKAY, NICHOLS, SCHROEDER.

423. **Seminar in English History to 1688.** 1 unit. HILL.

425. **Seminar in English and British Empire History Since 1688.** 1 unit. ARNSTEIN.

427. **Seminar in Russian History.** 1 unit. FISHER, UROFF.

441. **Seminar in Near and Middle Eastern History.** 1 unit. DAWN.

443. **Seminar in South Asian History.** 1 unit. KLING.

445. **Seminar in East Asian History.** 1 unit. CRAWFORD.

451. **Seminar in Early American History to 1789.** 1 unit. STEARNS.

453. **Seminar in American History Since 1789.** 1 unit. HYMAN, JOHANNSEN, KRUEGER, MCCOLLEY, SOLBERG, SPENCE, SUTTON, WALLER.

461. **Seminar in Latin-American History.** 1 unit. LOVE, NOWELL.

471. **Seminar in the History of Science.** 1 unit. APPLEBAUM.

496. **History of Historiography.** Introduction to the great historians from early times to the present. 1 unit. STARR.

497. **Reading Course.** Directed reading in special fields. Open only to students with a master's degree or equivalent, who are preparing for the preliminary examination in history and who need instruction in areas not provided by current course offerings. 1 unit. Prerequisite: Master's degree or equivalent; consent of instructor. STAFF.

498. **Problems in the Teaching of College History.** No credit. Prerequisite: Candidate for Ph.D. degree in history. STAFF.

499. **Thesis Research.** Individual direction in research and guidance in writing theses for advanced degrees. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

The general prerequisite for all graduate students registering in 300-numbered courses is one year of college history or consent of instructor.

301. **The Middle Ages from 400 to 1100 A.D.** Europe from the fall of Rome to the first crusade. ½ or 1 unit. QUELLER.

302. **The Middle Ages from 1100 to 1500 A.D.** Europe from the rise of towns to the establishment of national monarchy. ½ or 1 unit. QUELLER.

303. **History of Byzantine Civilization.** A study of cultural, religious, and social history of the Eastern Roman Empire from Constantinople's foundation in 330 A.D. to the fall of Byzantium in 1453. Special attention is given to the continua-

tion of classical ideals and Byzantine relations with the Latin West and the Slavic and Muslim worlds. ½ or 1 unit.

304. **Medieval Civilization.** Religious and intellectual. ½ or 1 unit. Prerequisite: One year of college history or political science.

305. **The Age of the Renaissance.** ½ or 1 unit.

306. **The Age of the Protestant and Catholic Reformation, 1500 to 1648.** ½ or 1 unit.

307. **Classical Islam: The Near East from Mohammed to the Crusades.** ½ or 1 unit. DAWN.

308. **The Europeanization of the Near East, 1768 to 1914.** ½ or 1 unit. DAWN.

309. **Development of Modern Europe: Absolutism and Colonial Expansion, 1648 to 1789.** ½ or 1 unit. SIRICH.

310. **Development of Modern Europe: The French Revolution and Napoleon, 1789 to 1815.** ½ or 1 unit. SIRICH.

311. **European History from 1815 to 1871.** ½ or 1 unit. Prerequisite: One year of college history, political science, or economics. NICHOLS.

312. **European History from 1871 to 1918.** ½ or 1 unit. Prerequisite: One year of college history, political science, or economics. NICHOLS.

313. **European History from 1918 to 1939.** ½ or 1 unit. Prerequisite: One year of college history, political science, or economics.

314. **European History from 1939 to the Present.** ½ or 1 unit. Prerequisite: One year of college history, political science, or economics.

315. **Economic and Social History of Europe to 1815.** A history and analysis of the development of European economy and society from the Middle Ages to the Industrial Revolution; evolving agrarian systems; growth of commercial economies; industrial and technical progress; colonial expansion. ½ or 1 unit. Prerequisite: One year of college history or economics, or consent of instructor. MCKAY.

316. **Economic and Social History of Europe Since 1815.** A comparative study of the Industrial Revolution in England, France, Germany, and Russia; social, cultural, and demographic consequences of rapid economic change; expanding world economy and modern imperialism. ½ or 1 unit. Prerequisite: One year of college history or economics, or consent of instructor. MCKAY.

317. **Modern Italy, 1815 to the Present.** A survey of Italian political, social, economic, and cultural developments from the aftermath of the Napoleonic wars to the post-Second World War republic. ½ or 1 unit.

318. **Modern European Diplomatic History, 1789 to 1890.** The diplomatic history of Europe from the French Revolution to the fall of Bismarck. ½ or 1 unit. SCHROEDER.

319. **Modern European Diplomatic History, 1890 to the Present.** The diplomatic history of Europe from the fall of Bismarck to the present day. ½ or 1 unit. SCHROEDER.

320. **Russia from the Earliest Times to Peter the Great.** The political, economic, cultural, and social development of Russia during the Kievan and Muscovite periods. ½ or 1 unit. UROFF.

321. **Russia from Peter the Great to 1855.** The political, economic, cultural, diplomatic, and social development of Russia during Imperial times. ½ to 1 unit.

322. **Germany Since 1890.** Germany as a modern industrial society, with emphasis

on the breakdown of German constitutionalism and the nature of National Socialism and the totalitarian state. ½ or 1 unit. FRANK.

323. **Intellectual History of Modern Europe, 1513 to 1770.** A survey of the seminal ideas in the fields of political, social, and economic thought which have influenced the development of modern Europe. ½ or 1 unit. SIRICH.

324. **Intellectual History of Modern Europe, 1770 to the Present.** A survey of the seminal ideas in the fields of political, social, and economic thought which have influenced the development of modern Europe. ½ or 1 unit. SIRICH.

325. **Intellectual and Cultural History of Russia to 1881.** ½ or 1 unit. UROFF.

326. **Intellectual and Cultural History of Russia from 1881 to the Present.** ½ or 1 unit. Prerequisite: One year of college history or political science, or consent of instructor. UROFF.

327. **Russia from 1855 to the Bolshevik Revolution of 1917.** ½ or 1 unit. FISHER.

328. **History of Soviet Russia from 1917 to the Present.** ½ or 1 unit. Prerequisite: One year of college history or political science, or consent of instructor. FISHER.

329. **History of Southeastern Europe, Fourteenth to the Eighteenth Century.** The Byzantine heritage, the Ottoman conquest and its impact upon the peoples of the Balkans, and the internal political and cultural history of the Rumanians, South Slavs, Greeks, and Albanians to 1804. ½ or 1 unit.

330. **History of Southeastern Europe Since 1804.** The rise of nationalism and the formation of national states in the Balkans, the decline of the Ottoman Empire, and the political and cultural history of Rumania, Yugoslavia, Bulgaria, Greece, and Albania in the nineteenth and twentieth centuries. ½ or 1 unit.

332. **Medieval England.** Religious, social, intellectual, and economic developments in medieval England from the period of the Germanic invasions to the accession of the Tudors. ½ or 1 unit. HILL.

333. **Great Britain Under the Tudors and Stuarts, 1485 to 1660.** The principal political, economic, social, religious, and cultural developments in British history, including Scotland and Ireland, from the beginning of the Tudor dynasty to the Restoration of 1660. ½ or 1 unit.

334. **Great Britain Under the Later Stuarts and the Hanoverians, 1660 to 1815.** The principal political, economic, social, religious, and cultural developments in British history from the Restoration to the end of the Napoleonic wars. ½ or 1 unit.

337. **Economic History of American Agriculture.** Same as Agricultural Economics and Economics 337. The development of American agriculture from early colonial times to the present. Emphasis on regional development, evolution of methods and equipment, trends in marketing and credit, and the making of federal farm policy. ½ or 1 unit. Prerequisite: A college-level course in basic economics or American history. SCHWEITZER.

338. **History of Cosmology.** A history of man's changing conceptions of the structure and origin of the universe from the ancient creation myths to modern times. The relationships between cosmological theories and developments in the physical sciences, philosophy, religion, and social and cultural factors are explored. ½ or 1 unit. Prerequisite: One year of college history or philosophy, or consent of instructor. APPLEBAUM.

339. **History of the British Commonwealth in the Nineteenth Century, 1783 to 1900.** ½ or 1 unit. ARNSTEIN.

340. **History of the British Commonwealth in the Twentieth Century, 1901 to the Present.** ½ or 1 unit. ARNSTEIN.

341. Modern Britain: The Victorian Era, 1815 to 1900. A history of the political, constitutional, social, economic, and diplomatic developments of the United Kingdom, including Ireland. ½ or 1 unit. ARNSTEIN.

342. Modern Britain Since 1900. A history of the political, constitutional, social, economic, and diplomatic developments of the United Kingdom, including Ireland. ½ or 1 unit. ARNSTEIN.

345. Constitutional History of England to 1485. Important for those who intend to study law. ½ or 1 unit. Prerequisite: One year of college history or political science. HILL.

346. Constitutional History of England, 1485 to the Present. Important for those who intend to study law. ½ or 1 unit. Prerequisite: One year of college history or political science. HILL.

347. The Emergence of Modern Science to the Age of Newton. A history of science from ancient times to the age of Newton. ½ or 1 unit. Prerequisite: One year of college history or philosophy, or consent of instructor. APPLEBAUM.

348. The History of Modern Science Since the Age of Newton. The development of the sciences and scientific principles since the age of Newton. ½ or 1 unit. Prerequisite: One year of college history or philosophy, or consent of instructor. APPLEBAUM.

349. The Scientific Revolution, 1543 to 1727. A study of the birth of modern science in the seventeenth century, with special emphasis upon the rise of experimentalism, the growth of mathematical science, and the establishment of the mechanical philosophy. ½ or 1 unit. APPLEBAUM.

350. History of American Immigration to 1880. The migrations which peopled the English colonies and the United States and their role in the shaping of American society and culture. ½ or 1 unit. Prerequisite: One year of college history or consent of instructor.

351. History of American Immigration Since 1880. Late nineteenth- and early twentieth-century migrations and their impact on American society and culture. ½ or 1 unit. Prerequisite: One year of college history or consent of instructor.

352. Colonial Beginnings of American Life and Institutions. A study of the seventeenth- and eighteen-century colonies. ½ or 1 unit. STEARNS.

353. American Negro History. Negroes in America from the development of the slave trade through emancipation and up to the present; emphasis is on the fifteenth- to seventeenth-century origins of modern slavery; some attention is given to slavery and emancipation throughout the Western hemisphere. ½ or 1 unit. MCCOLLEY.

354. The Era of the American Revolution, 1763 to 1789. ½ or 1 unit. STEARNS.

355. Federalists, Jeffersonians, and the Era of Good Feelings. United States history from 1789 to 1828 with emphasis on the conflict between nationalism and sectional interests. ½ or 1 unit. MCCOLLEY.

356. History of the United States, Jackson to the Civil War. Study of Jacksonian democracy; the rise of sectionalism; manifest destiny and the Mexican War; the issue of slavery and expansion and the approach of the Civil War. ½ or 1 unit. JOHANNSEN.

357. Economic History of the United States, 1775 to 1860. The growth of American economic life and institutions from the Revolution to the outbreak of the Civil War. ½ or 1 unit. SPENCE.

358. Economic History of the United States Since 1860. The growth of American economic life and institutions since 1860. ½ or 1 unit. SPENCE.

359. **The Civil War and Reconstruction.** Remote and immediate causes of the Civil War, especially from 1850 to 1861; problems of the North and South during the war; the consequences of the war; the efforts to create a new Union, 1865 to 1877, and the new problems created by those efforts. ½ or 1 unit. JOHANNSEN.

360. **History of the United States, 1877 to 1909.** ½ or 1 unit. Prerequisite: One year of college history, political science, or economics. BATES.

361. **History of the United States, 1909 to 1932.** ½ or 1 unit. Prerequisite: One year of college history, political science, or economics. BATES.

362. **History of the United States Since 1932.** ½ or 1 unit. Prerequisite: One year of college history, political science, or economics. KRUEGER.

363. **Social History of Industrial America to 1890.** The impact of industrialization, immigration, and urbanization on American society in the nineteenth century. ½ or 1 unit.

364. **Social History of Industrial America Since 1890.** A study of the impact of industrial technology, business enterprise, immigration, and urbanization on American society. ½ or 1 unit.

365. **The History of Illinois to 1870.** Evolution of a typical midwestern commonwealth, with emphasis upon its political, economic, social, religious, and cultural development in the nineteenth century. ½ unit. SUTTON.

366. **The History of Illinois from 1870 to the Present.** The evolution of a modern American state, with emphasis upon its political life, economic growth, social and intellectual problems, and its contribution to the American nation. ½ unit. SUTTON.

367. **The Trans-Mississippi West.** The history of Western expansion since the Louisiana Purchase; the West in the general history of the United States; Western economic and political problems. ½ or 1 unit. SPENCE.

368. **History of the South.** An inquiry into the question, when did the South begin and what have been its distinguishing traits? Special attention is given to agrarianism, industrialization, and the race problem. ½ or 1 unit. BATES.

369. **Constitutional Development of the United States to 1865.** ½ or 1 unit. Prerequisite: One year of college history or political science.

370. **Constitutional Development of the United States Since 1865.** ½ or 1 unit. Prerequisite: One year of college history or political science.

371. **American Intellectual and Cultural History to 1877.** Social and political thought, religion, science, scholarship, and education as both results and causes of American experience. ½ or 1 unit. SOLBERG.

372. **American Intellectual and Cultural History Since 1877.** The contribution of social and political thought, religion, science, scholarship, and education to the history of American civilization. ½ or 1 unit. SOLBERG.

373. **Diplomatic History of the United States to the End of the Nineteenth Century.** ½ or 1 unit. Prerequisite: One year of college history or political science.

374. **Diplomatic History of the United States in the Twentieth Century.** ½ or 1 unit. Prerequisite: One year of college history or political science.

375. **History of Latin America to 1824.** A survey of Latin-American history from the discovery of America until 1824. ½ or 1 unit. NOWELL.

376. **Latin America Since 1824.** A history of the Latin-American republics from their independence to the present. ½ or 1 unit. NOWELL.

377. **History of Modern Brazil from 1808 to the Present.** An analysis of developments from 1808, emphasizing the advances and discontinuities in the growth of a

neocolonial, agricultural society into an urban, industrial polity. ½ or 1 unit. Prerequisite: One year of college history or enrollment in Latin-American studies program. LOVE.

378. **History of Modern Mexico, 1765 to the Present.** The development of Mexico from the Bourbon reforms of the Enlightenment to the post-revolutionary present, with emphasis on social, economic, and political change; social science concepts of economic underdevelopment, social integration, and nation-building. ½ or 1 unit. Prerequisite: Enrollment in the Latin-American studies program. LOVE.

381. **Ancient Greek States.** History of the Greek states from the earliest times to 334 B.C. ½ or 1 unit. STARR.

382. **Alexander and His Successors.** ½ or 1 unit. STARR.

383. **History of the Roman Republic to 44 B.C.** ½ or 1 unit. MITCHELL.

384. **The Roman Empire.** ½ or 1 unit. MITCHELL, STARR.

387. **Indian History and Civilization to 1707.** Development of Indian civilization up to the British conquest. Political evolution; religious and philosophical systems; society, art, and literature during Hindu and Muslim periods. ½ or 1 unit. KLING.

388. **Development of Modern India and Pakistan from 1707.** Establishment and organization of the British Empire in India; reaction of India to the Western impact; growth of nationalism and the struggle for independence. ½ or 1 unit. KLING.

389. **Problems of Contemporary South Asia.** Current political, economic, social, and cultural problems of India, Pakistan, and Ceylon dealt with in the perspective of the historical development of South Asia. ½ or 1 unit. KLING.

390. **China Under the Ch'ing Dynasty.** The period of Manchu domination in China (1644 to 1912). Emphasis is on Chinese reactions to Western influences during the nineteenth century. ½ or 1 unit. CRAWFORD.

391. **A History of China to 906 A.D.** A history of the formative period of the Chinese state, society, and economy. ½ or 1 unit. CRAWFORD.

392. **History of China, 907 to 1644.** A history of the early modern Chinese state and society prior to the Western impact. ½ or 1 unit. CRAWFORD.

393. **Chinese Intellectual History from Earliest Times to the Present.** A study of the major ideas and schools of thought as they have affected the course of Chinese history and the development of its institutions. ½ or 1 unit. EASTMAN.

394. **Twentieth-Century China.** Chinese state and society in revolutionary transition; emphasis on the Nationalist and Communist revolutions and their results. ½ or 1 unit. EASTMAN.

395. **Premodern Japan.** Japanese history from its origins to 1800; evolution of the traditional society, stressing institutional and cultural problems of the ancient, "feudal," and early modern (Tokugawa) period. ½ or 1 unit.

396. **Modern Japan.** Japanese history since 1800; institutional and cultural problems connected with Western pressure, the Meiji Restoration, rise and fall of empire, and creation of a modern society. ½ or 1 unit.

398. **Intellectual History of Japan.** Shinto, Buddhism, Confucianism, and Western thought as cultural and social forces in the evolution of Japan from its origins to the present. ½ or 1 unit. Prerequisite: One year of college history or philosophy.

HOME ECONOMICS

The Department of Home Economics offers work leading to the Master of Science or Master of Arts in Home Economics; Master of Science in Home Economics Education; and Doctor of Philosophy in Home Economics with a major in foods and nutrition. The major work for a master's degree in home economics may be done in one of six curricula as shown below. The minimum grade-point average for admission to graduate study in home economics and home economics education is 3.75. Applications of students with averages below 3.75 but above 3.5 are considered on an individual basis.

Master of Science or Master of Arts. Candidates for a master's degree in home economics must complete a minimum of eight units (nine if a thesis is not submitted), of which at least four must be in home economics. Four of the total units, including at least two in home economics, must be in 400-level courses.

Lists of suggested electives for each curriculum are available from the department upon request. Required courses for each of the six curricula are given below:

(1) *Child Development and Family Relationships.* A minimum of four units from Home Economics 301, 410, 418, 419, and 499.

(2) *Family and Consumption Economics.* A minimum of four units from Home Economics 313, 370, 379, 470, 499, with credit in Home Economics 370 and 499 required. A minimum of two units from Economics 300, 301, 400-401, or 402-403.

(3) *Family Housing and Household Management.* A minimum of nine units; two from Home Economics 361, 370, 375, 378, 379, and 470; Agricultural Engineering 300, and Architecture 339; three units from Home Economics 380, 410, 418, 419, 480, 487, and 493; two units from Economics 313, Finance 369, Sociology 407, 476, 477.

(4) *Foods and Nutrition.* A minimum of four units from Home Economics 320, 322, 324, 330, 331, 422, 423, 430, 432, and 499; also, Chemistry 354, or 350 and 355 are required.

(5) *General Home Economics.* A minimum of four units from prescribed courses in three of the other five curricula in home economics.

(6) *Textiles and Clothing.* A minimum of four units from Home Economics 375, 380, 386, 388, 395, 480, 487, and 499.

Candidates for the Master of Science in Home Economics Education must earn eight units, four of them in home economics. Three of the eight units must be in 400-numbered courses and at least one of these must be in home economics. Courses in home economics are to be chosen from Home Economics 301, 320, 322, 323, 326, 330, 331, 361, 375, 378, 379, 380, 386, 388, 395, 410, 418, 419, 480, and 487; Educational Psychology 311 and 312, one unit; two of the following courses: History and Philosophy of Education 301, 302, 303, 304, one unit; Vocational and Technical Education 453, one unit; Vocational and Technical Education 456, one unit, or Home Economics 377, one-half to one unit. See pages 45 and 46.

Doctor of Philosophy. Candidates for this degree with a major in foods and nutrition must present an undergraduate foods course with an organic chemistry prerequisite; a nutrition course with organic chemistry and physiology prerequisites; adequate training in chemistry, including quantitative analysis and organic; and introductory courses in microbiology, physics, and trigonometry. A student emphasizing foods in the doctoral program should have had a course in colloid chemistry. Deficiencies in these requirements may be made up during the first year of graduate study.

Required courses include at least three units of foods and nutrition, two at the 400 level; one unit of statistical methods at the 400 level; courses in biochemistry and physical chemistry; and an advanced course in food microbiology or mammalian physiology. Additional courses in the above areas or in animal nutrition or food science are selected to satisfy major unit requirements. Candidates may minor in animal nutrition, biochemistry, food science, microbiology, physiology, and other appropriate areas. Either foods or nutrition is emphasized in research for the thesis.

Graduate students who choose an area of home economics as a minor for the Doctor of Philosophy must complete three units for a first minor or two units for a second minor in addition to credit offered for the master's degree. At least one unit must be taken in 400-level courses.

GRADUATE FACULTY

Professors: Janice M. Smith (Head of Department), Marilyn M. Dunsing, Ruth L. Galbraith, Lorraine D. Trebilcock, Frances Van Duyne.

Associate Professors: Margaret Goodyear, Beulah Hunzicker, Glenna H. Lamkin, Queenie B. Mills, Willie Mae Mowrer.

Assistant Professors: Karlyne Anspach, Esther L. Brown, Beula V. McKey.

COURSES FOR GRADUATES

410. Problems in Family Living. Family relationships and their significance to the growth of family members. 1 unit. Prerequisite: Home Economics 210. Mowrer.

418. Seminar in Child Development. Advanced problems in child development. 1 unit. Prerequisite: Home Economics 301. Mowrer, Van den Daele.

419. Seminar in Family Relationships. Critical evaluation of research literature in the field of marriage and family relationships. 1 unit. Prerequisite: Home Economics 410. Mowrer.

422. Seminar in Nutrition. A study of recent literature in nutrition. ½ or 1 unit. Prerequisite: Undergraduate degree in home economics, with emphasis on foods and nutrition, or comparable background in biochemistry, microbiology, physiology, or other biological science.

423. Problems in Human Nutrition. Methods of assessing nutritional status of humans. ½ or 1 unit. Offered in 1968-1969 and in alternate years. Prerequisite: Home Economics 324 or equivalent.

430. Carbohydrates in Foods. Same as Food Science 430. A study of the physical and chemical properties of carbohydrates used in food and their behavior under conditions encountered in food processing and storage. ¾ unit. Prerequisite: Chemistry 354 or 350 and 355, or consent of instructor.

432. Seminar in Foods. Review of current literature in foods research. ½ or 1 unit. Prerequisite: Undergraduate major in foods and nutrition, chemistry, microbiology, or physiology; consent of instructor. Van Duyne.

470. Seminar in Family and Consumption Economics. Same as Agricultural Economics 470. Discussion of current topics and review of the literature in family and consumption economics. ½ or 1 unit. Prerequisite: Economics 102 or 108 and a course in applied statistics; Home Economics 313, 370, or consent of instructor. Dunsing.

480. Seminar in Textiles. Current literature related to development in the production, use, and care of textile fabrics. ½ or 1 unit. Prerequisite: Home Economics 380 or equivalent; consent of instructor. Galbraith.

487. Seminar in Clothing. Study and discussion of reseach in clothing from the aspects of psychological and sociological factors contributing to the effect of clothing on the development of individuals and on family and community group reactions. ½ or 1 unit. Prerequisite: Undergraduate curriculum with majors in textiles and clothing, home economics education, home economics extension, or general home economics. Anspach.

493. Advanced Studies in Home Economics. Library or experimental research on

specific problems of limited scope. Work may be taken in the following subjects: (a) child and family, (b) family and consumption economics, (c) family housing, (d) foods, (e) nutrition, (f) textiles and clothing. This is one of the courses which may be taken in addition to eight units required for a master's degree by students who do not write a thesis. ½ or 1 unit. STAFF.

499. **Thesis Research.** Work may be taken in the following subjects: (a) child and family, (b) family and consumption economics, (c) family housing, (d) foods, (e) nutrition, (f) textiles and clothing. 0 to 4 units. DUNSING, GALBRAITH, MILLS, MOWRER, J. SMITH, VAN DUYNE.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Advanced Problems in Home Guidance of Children.** Emphasis is placed upon the functions and relations of routine and creative activities and the interplay of personalities in the total behavior patterns with a view to helping students understand the less obvious and more subtle aspects of child development, to differentiate between desirable and undersirable guidance procedures practiced by adult members of the family. ½ or 1 unit. Prerequisite: Home Economics 202 and 203; consent of instructor. MOWRER.

313. **Economics of Consumption.** Same as Economics 313. An analysis of the macro and micro aspects of consumption. ½ or 1 unit. Prerequisite: Economics 102 or 108; a course in applied statistics. DUNSING.

320. **Diet in Disease.** ½ unit. Prerequisite: Home Economics 220. BROWN.

322. **Physical Growth and Nutrition.** Lectures, readings, and discussions. ½ unit. Prerequisite: Home Economics 220; consent of instructor. BROWN.

323. **Recent Advances in Foods and Nutrition.** New developments in foods and nutrition. Readings, lectures, and discussions. S; ½ unit. Prerequisite: Chemistry 102 or 133; Physiology 103; Home Economics 220 and 231. MCKEY, VAN DUYNE.

324. **Problems in Nutrition.** Discussions and investigations. ½ or 1 unit. Prerequisite: Home Economics 220; Chemistry 354 or 350 and 355; senior standing. NORDSTROM.

326. **Presentations: Principles and Techniques.** Selection of problems and organization of materials for demonstrations and other presentations in home economics subject matter areas. Field trip; estimated cost, $15.00. ½ unit. Prerequisite: Senior standing; consent of instructor. LAMKIN.

330. **Experimental Foods.** A consideration of the manner in which such variables as ingredients, proportions, and techniques in food preparation affect the quality of the product. ½ or 1 unit. Prerequisite: Home Economics 231; Microbiology 100 and 101.

331. **Problems in Foods.** Individual problems in food preparation and preservation. ½ unit. Prerequisite: Home Economics 330. VAN DUYNE.

345. **Institution and Restaurant Management: Food Purchasing and Equipment Selection.** Purchasing food and selecting equipment for quantity food service; factors affecting the purchase of food; relationship of floor plans and equipment to service. ½ unit. Prerequisite: Credit or registration in Home Economics 240; Economics 108.

349. **Music in Early Childhood.** Same as Music 349. A detailed consideration of the music program in nursery schools, kindergarten, and the primary grades. Topics covered include the nature of early musical responses, objectives, and experience levels of the program, methods of teaching, and materials. Observation of music teaching in the Child Development Laboratory is included in the course work.

½ unit. Prerequisite: Senior or graduate standing in music education or child development. R. SMITH.

350. **Institution and Restaurant Management: Organization and Administration.** The organization and administration of food service operations; management problems in various types of food service, personnel, costs, sanitary control. Field trips; estimated cost, $20.00 to $25.00. ½ or 1 unit. Credit is not given for both Home Economics 350 and 351. Prerequisite: Home Economics 220 and 240. HUNZICKER.

351. **Special Problems in Group Feeding.** For individuals interested in refreshing and strengthening knowledge in group feeding. Lectures, discussions, laboratory practice in quantity food management. Food handler's certificate required. No credit for students who have completed Home Economics 240, 345, or 350. S; ½ unit. Prerequisite: Home Economics 220 and 231, or equivalent; consent of instructor.

355. **Specialized Quantity Food Production and Management.** Advanced application of food production and management principles to special food service demands. Emphasis on artistry in preparation, serving, and merchandising high quality food in quantity. ½ unit. Prerequisite: Home Economics 240, credit or registration in Home Economics 350, or consent of instructor.

361. **Development and Function of Family Housing.** Same as Agricultural Mechanization 361. Study of principles and problem solutions in family housing; basic functions, plan patterns, types, materials, and structure; economic influences, costs, and adaptations; personal and public interests. ¾ unit. Prerequisite: Home Economics 160 and 171, or consent of department. HANSEN.

370. **Family Economics.** Same as Agricultural Economics 370. Economic welfare of American families in terms of cost of living, standard of living, income, and net worth. ½ or 1 unit. Prerequisite: Economics 102 or 108; a course in applied statistics. DUNSING.

375. **Home Equipment.** A survey course in which the basic principles related to the selection, use, and care of household equipment are considered. Individual problems include an evaluation of sources of information on equipment and equipment performance tests. ½ unit. Prerequisite: Home Economics 171; six advanced hours in home economics, including one of the following: Home Economics 231, 273, 380; consent of instructor.

377. **Cooperative Extension: Home Economics.** The philosophy, history, and organization of the cooperative extension service. Consideration of program development, methods of presentation, and evaluation with emphasis on socio-economic characteristics of state and county. ½ to 1 unit. Prerequisite: Economics 108; Psychology 100 and Sociology 100, or Educational Psychology 211, or Agriculture 206; consent of instructor. DUNLAP.

378. **Problems in Home Management.** Individual investigation and reports of specific problems in the fields of family housing, home furnishings, and home management. ½ to 1 unit. Prerequisite; Home Economics 262 or 270; consent of instructor. ALEXANDER, GOODYEAR.

379. **Problems in Family and Consumption Economics.** Individual investigation of specific problems in the field of family and consumption economics. ½ or 1 unit. Prerequisite: Economics 102 or 108; a course in applied statistics; Home Economics 313, 370, or consent of instructor. DUNSING.

380. **Advanced Textiles.** The effect of the physical and chemical structures of textile fibers on their properties, manufacturing processes, use, and care. 1 unit. Prerequisite: Home Economics 183; Chemistry 102 or 132. GALBRAITH.

386. Clothing Design: Draping. Designing by draping, inspired by appropriate design sources; understanding of fitting principles through fabric manipulations; design effects maintained in garment construction. 1 unit. Prerequisite: Home Economics 285 or consent of instructor; Home Economics 286. ANSPACH.

388. Problems in Textiles and Clothing. Investigation and report of individual problems in the field of textiles and clothing. ½ or 1 unit. Prerequisite: Home Economics 286 or 380 or Marketing 211; consent of instructor. ANSPACH, GALBRAITH, TREBILCOCK.

395. Fashion Analysis. A study of fashion terminology, selected designers, garment manufacturing techniques, and methods of fashion promotion used in retail outlets. Field trip; estimated cost, $10.00. ½ unit. Prerequisite: Advertising 281; consent of instructor. TREBILCOCK.

HORTICULTURE

Graduate work is offered in the Department of Horticulture leading to the Master of Science and Doctor of Philosophy degrees. Students may specialize in any phase of horticulture including genetics, physiology, ecology, developmental anatomy, or marketing. Apiculture is offered jointly with the Department of Entomology. Well-equipped laboratories and extensive experimental farms are available for each area of specialization within the department. Special facilities available on campus include the computer laboratory, electronmicroscope laboratory, and radiocarbon laboratory. A well-balanced program may be achieved by taking courses in agronomy (crops or soils), botany, food science, genetics, statistics, plant pathology, chemistry, biochemistry, entomology, or agricultural economics. Students may minor in any of these fields.

Applicants with a grade-point average of 4.0 or above for the last sixty semester credit hours of course work for the bachelor's degree are admitted for graduate study in horticulture. Applicants with an average below 4.0 but above 3.75 are considered on an individual basis. Applicants should have adequate preparation in the fundamental sciences.

A minimum of eight units must be completed for the master's degree. A candidate for the degree of Doctor of Philosophy must complete eight units of courses beyond the master's degree, satisfy the language requirements, and pass an oral preliminary examination. The candidate must also complete eight units of thesis research and submit an acceptable thesis.

Additional information concerning specific requirements and opportunities in graduate research is available from the Head of the Department of Horticulture, 125 Mumford Hall.

GRADUATE FACULTY

Professors: C. J. BIRKELAND (Head of Department), C. Y. ARNOLD, J. R. CULBERT, D. F. DAYTON, J. B. GARTNER, M. B. LINN, R. V. LOTT, J. P. MCCOLLUM, D. POWELL, R. K. SIMONS, A. E. THOMPSON, J. S. TITUS, J. S. VANDEMARK.

Associate Professors: H. C. BARRETT, E. R. JAYCOX, A. M. RHODES, C. C. ZYCH.

Assistant Professors: L. BEEVERS, J. D. BUTLER, D. B. DICKINSON, T. K. HODGES, H. J. HOPEN, M. M. MEYER, W. E. SPLITTSTOESSER.

COURSES FOR GRADUATES

424. Mineral Nutrition of Plants. Same as Agronomy and Botany 424. A study of the uptake, transport, and metabolic utilization of mineral nutrients by plants. The

scope of the course is to present the essentiality of various anions and cations in the light of metabolic activity and constituency in functional plant compounds. Major emphasis is placed on metabolic activity and function of the elements. 1 unit. Prerequisite: Botany 330 or consent of instructor. HAGEMAN.

440. **Design and Analysis of Biological Experiments, I.** Same as Agronomy, Animal Science, Dairy Science, Forestry, and Veterinary Medical Science 440. A study of statistical methods as tools for research. Principles of designing experiments and the methods of analysis for various kinds of designs are considered from the viewpoint of when and how to use the available simpler designs and analytical methods. 1 unit. Prerequisite: Consent of instructor.

441. **Design and Analysis of Biological Experiments, II.** Same as Agronomy, Animal Science, Dairy Science, Forestry, and Veterinary Medical Science 441. A continuation of Horticulture 440 moving into the more complex designs and methods of analysis. 1 unit. Prerequisite: Horticulture 440 or equivalent.

447. **Horticulture Seminar.** Discussion of current research and literature pertaining to problems of horticulture and related fields. ¼ unit. STAFF.

490. **Research Methods in Horticulture.** Lectures, discussions, demonstrations, and laboratory exercises dealing with methods and apparatus used in horticultural research. 1 unit. Prerequisite: Chemistry 133 or equivalent; Chemistry 122 or equivalent; Botany 330; five hours of physics. STAFF.

492. **Special Topics in Horticulture.** Readings and discussions in selected phases of horticulture including such topics as genetics, physiology, anatomy, morphology, and ecology of horticultural crops. ½ to 2 units. Prerequisite: Twenty hours of undergraduate work in horticulture and allied subjects for a major and twelve hours for a minor. STAFF.

499. **Thesis Research.** Research on the thesis problem in floriculture, fruit breeding, pomology, and vegetable crops. Required in horticulture major. 0 to 4 units. Prerequisite: Twenty hours of undergraduate work in horticulture and allied subjects for a major and twelve hours for a minor. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

321. **Floricultural Physiology.** A study of the physiology and metabolism of floricultural crops during their development from seeds through flowering. Lectures and discussion. 1 unit. Prerequisite: One semester of organic chemistry and introductory plant physiology, or equivalent. BEEVERS.

322. **Plant Nutrition.** A study of the mechanisms of and factors affecting the absorption, transport, and functions of the essential elements required by higher plants. Lectures, discussions, and laboratory. 1 unit. Prerequisite: One semester of organic chemistry and introductory plant physiology, or equivalent. HODGES.

323. **Principles of Plant Breeding.** Same as Agronomy 323. Genetic and cytological variation in crop plants, the production and control of such variation in developing varieties and hybrids, the maintenance of high quality seed stocks. Field trips; estimated cost, $5.00. 1 unit. Prerequisite: Agronomy 110 or equivalent; Botany 100. HADLEY, HITTLE, THOMPSON.

335. **Economics of Food Distribution.** Same as Agricultural Economics 335, Analysis of (1) marketing structures and operations in the manufacture and wholesale and retail distribution of food; (2) effects of industry organization and governmental regulations on marketing functions and efficiency; (3) consumer demand for food. ¾ or 1 unit. Prerequisite: Economics 108; Agricultural Economics 230 or an elementary marketing course. KELLY.

345. **Growth and Development of Horticultural Corps.** Factors affecting growth, development, and quality of vegetable crops. Lecture and discussion. 1 unit.

Offered in 1969-1970 and in alternate years. Prerequisite: Botany 230 or equivalent, or consent of instructor. McCollum.

361. **Individual and Group Behavior of Honey Bees.** Same as Entomology and Zoology 361. Study of individual and group behavior of honey bees, their biological value, physical basis, and evolution. Lectures and discussions, one or more local field trips, term paper, and assigned reading. ½ unit. Prerequisite: One semester of entomology or zoology. Jaycox.

HUMANITIES

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

363. **Introduction to Comparative Literature, I.** Same as Comparative Literature 363. A one-year course in two parts, offering a survey of methods and goals of comparative literature, illustrated by representative examples taken from several literatures and studies of modern criticism. ¾ unit.

364. **Introduction to Comparative Literature, II.** Same as Comparative Literature 364. Continuation of Humanities and Comparative Literature 363. ¾ unit.

INDUSTRIAL ADMINISTRATION

The Department of Industrial Administration offers graduate work either as a major or a minor leading to the Master of Science in Management, and as a minor for the Doctor of Philosophy.

Admission requires a grade-point average of 4.0 for the last sixty hours of undergraduate study. Candidates with a grade-point average from 3.75 to 4.0 may be considered on an individual basis. Such students may be required to take an appropriate examination such as the Admission Test for Graduate Study in Business (fee, $10.00).

To do major work in the field of management, a student must have completed at least twenty hours of undergraduate work in business administration and related subjects. To do minor work in this field, at least twelve hours of work in business administration and related subjects are required.

GRADUATE FACULTY

Professors: R. M. Hill (Acting Head of Department), P. M. Dauten, Jr., P. C. Roberts.

Associate Professors: R. L. Black, R. N. Corley, D. R. Day, H. Hinomoto, B. F. Kirkpatrick.

COURSES FOR GRADUATES

401. **Scientific Management, I.** Same as Industrial Engineering 401. A study of modern management principles on the basis of quantitative methods, concentrating on such operations research techniques as nonlinear and dynamic programming and queueing theory. 1 unit. Prerequisite: Industrial Engineering 386 and Mathematics 361, or consent of instructor.

402. **Scientific Management, II.** Same as Industrial Engineering 402. A systems approach to industrial problems involving inventory control, scheduling and line balancing, maintenance and investment theory; application of formally accumulated knowledge of operations research techniques. Problems from industry are assigned to small teams of students. 1 unit. Prerequisite: Industrial Administra-

tion or Industrial Engineering 401; background in computer technology or consent of instructor.

416. Problems in Business Policy. Advanced problems in policy evaluation, determination, execution, administration, and control. Policy objectives in integration of product, marketing, manufacturing, finance, and organization. 1 unit. Prerequisite: Consent of instructor.

448. Problems of Personnel Management. Same as Labor and Industrial Relations 448. An examination of the organization and administration of the personnel function in management. This course deals with the relations of personnel administration to operating departments, and the scope of business and industrial personnel services. Analytical appraisal of policies and practices in selected areas of personnel administration, such as selection and training, is carried out through case studies and direct industrial contracts. Specific consideration is given to problems up to and including placing the person on a job. 1 unit. Prerequisite: Industrial Administration 351 or equivalent, or consent of instructor.

449. Problems of Personnel Management. Same as Labor and Industrial Relations 449. A seminar and laboratory course dealing with the problems and practices encountered by personnel managers subsequent to the employment process. Students do field work in businesses and industries in the area on such topics as incentives, rating, employee services, and community relations. 1 unit. Prerequisite: Industrial Administration 351, 448, or equivalent.

491. Seminar in Special Topics. For lectures in topics of current interest not covered by regular course offerings. Subjects will be announced in the Time Table. ¼ to 1 unit. Prerequisite: Consent of instructor or department head.

499. Thesis Research. 1 unit. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Business Torts. Liability of businessmen for their wrongful acts and those of their agents arising separate and apart from their liabilities under contracts, covering their duties to business visitors, invasion of one's right of privacy, conspiracy, slander, libel, malpractice, including breach of contract. ¾ or 1 unit. Prerequisite: Industrial Administration 200 or 261; senior standing.

301. The Law of Security Transactions and Banking. Significant phases of law in the fields of pledges, chattel mortgages, conditional sales, suretyship, insurance, real property, banks and banking, and bankruptcy. Under real property, real estate mortgages, landlord and tenant and mechanics liens are considered as well as the general principles of real property. ¾ or 1 unit. Prerequisite: Industrial Administration 200 or 261; senior standing.

302. Wills, Estates, and Trusts. A study of the basic legal and management principles and practices involved in the planning and administration of wills, estates, and trusts. ¾ or 1 unit. Prerequisite: Industrial Administration 200; senior standing.

311. Administrative Policies and Organization. Development of administrative organization and the determination of policies for the integration of major activities of a business enterprise. ½ or ¾ unit. Prerequisite: Industrial Administration 201; Marketing 201.

315. Management in Manufacturing. Internal problems of production and efficient control in factories. ½ unit. Prerequisite: Industrial Administration 210.

321. Industrial Social Systems, I. Same as Labor and Industrial Relations 321. Particular forms of individual and group behavior in organizations within the constraints of the economic, social, technological, and physical environment; the relations between union and management; the interdependency of these factor

with the decisions managers make. ½ to 1 unit. Prerequisite: Industrial Administration 210; Psychology 100; Psychology 201 or consent of instructor.

323. **Industrial Social Systems, II.** Understanding of complex organizations; particular attention to ways of dividing work, achieving coordination, and issues connected with change and adaptation. ½ to 1 unit. Prerequisite: Industrial Administration 321; Psychology 201.

351. **Personnel Administration.** A study of concepts and methods used by the staff personnel unit in building and maintaining an effective work force in an industrial organization; development of ability to design the personnel subsystem within the firm and to deal effectively with problems encountered in such areas as recruitment, selection, training, and wage and salary administration; considerable emphasis upon case analysis, role playing, and research. Credit is not given for Industrial Administration 351 and Psychology 145 or 245 and Industrial Administration 448 or 449. ½ to 1 unit. Prerequisite: Economics 173 and 240; Industrial Administration 323.

353. **Industrial Relations Administration.** An investigation of union-management relations primarily at the company level for those planning careers in the industrial labor relations field; topics include grievance handling, disciplinary policies and procedures, arbitration and contract negotiations; emphasis is given to case study and role playing techniques. Credit is not given for both Industrial Administration 353 and Industrial Administration 448 or 449. ½ to 1 unit. Prerequisite: Industrial Administration 323; Economics 240.

JOURNALISM

The Department of Journalism offers graduate work leading to the Master of Science in Journalism. For the program leading to the Doctor of Philosophy in Communications, see page 124.

Admission to graduate work in journalism requires (1) completion of the requirements for a bachelor's degree in an institution of recognized standing, preferably with a major (normally twenty semester credit hours) in journalism or a related field such as English or the social sciences; and (2) a grade-point average of at least 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

Requirements for the master's degree include:

(1) A major of four units, or three units and one additional unit approved by the department. Candidates without acceptable undergraduate majors may be required to complete (a) one unit of Journalism 321, (b) one unit of advanced undergraduate courses in writing or editing, and (c) in individual cases, some combination of Journalism 204, 211, 223, and 291, without graduate credit.

(2) A minor of at least two units, normally in an area outside the College of Communications.

(3) A thesis of one unit (Journalism 499) or the preparation of a topic of general public interest for publication or broadcast (Journalism 490).

(4) A minimum of three units in courses at the 400 level, at least two of which must be in the major field.

(5) A comprehensive written examination in the student's major and minor fields and on the current master's reading list.

(6) A minimum total of eight units.

GRADUATE FACULTY

Professors: J. W. Jensen (Head of Department), T. Peterson, H. I. Schiller.

Associate Professors: J. W. Carey, G. G. Hanson, H. S. Maclay, J. H. Schacht, Nancy Wiggins.

Assistant Professor: T. A. Guback.

COURSES FOR GRADUATES

468. The Political Economy of Communications. Same as Communications 468. Analysis of the structure, policy, and behavior of such media of communication as newspapers, magazines, books, postal service, telegraph, telephone, broadcasting, and film, with special emphasis on their relationships to political order and the economy. 1 unit. Guback.

470. Communications and Popular Culture. Same as Communications 470. Problems of cultural analysis related to the media of communications; social implications of communications research. 1 unit. Carey, Guback, Schacht.

471. Proseminar in Communications, I. Same as Communications 471. A general discussion of the mass media of communications, their role as social institutions, their control, and support; content, audience, and effect of the mass media. 1 unit. Carey, Staff.

472. Proseminar in Communications, II. Same as Communications 472. A general discussion of the problem of communications, including the individual as a communicating system, symbolic processes, analysis of messages, psycholinguistics, and language as social behavior. 1 unit. Maclay, Staff.

473. History and Theory of Freedom of the Press. Same as Communications 473. Development of the Anglo-American press system and the idea of freedom of the press; contemporary mass media and their implications for freedom and democracy. 1 unit. Jensen.

474. Communications Systems. Same as Communications 474. Analysis of the structure and development of communications systems; examination of the role of communication in social change, political movements, and formal organizations. 1 unit. Carey, Schiller.

490. Special Topics in Journalism. ½ or 1 unit. Prerequisite: Consent of head of department. Staff.

492. Research Methods in Communications. Same as Communications 492. An introduction to the methods of empirical research in the behavioral sciences applicable to research problems in human communication, with emphasis on studies of mass communication. Lectures, readings, and laboratory practice. 1 unit. Prerequisite: An introductory statistics course or consent of instructor. Wiggins.

499. Thesis Research. 1 to 2 units. Prerequisite: Graduate standing in journalism. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. High School Journalism. Journalistic writing in the high school; newspaper study and training of newspaper readers; supervision of school publications and publicity; junior college courses in journalism. ½ unit. Prerequisite: Consent of instructor. Gilmore.

321. News Editing. Newspaper desk work; editing the news; correction of faulty news stories; handling wire copy. Attention to headwriting, news pictures, and make-up and design of newspaper pages. 1 unit. Prerequisite: Credit or registration in Journalism 204; Journalism 212 or consent of instructor. Gilmore, Puffenbarger, Schacht.

323. **Advanced Reporting.** Advanced types of news investigation and treatment. ½ unit. Prerequisite: Journalism 211 and 212, or equivalent. PUFFENBARGER.

326. **Magazine Article Writing.** Preparation of feature stories and articles; techniques of marketing, market analysis, and publishing articles written in the course. ½ unit. Prerequisite: Journalism 211 or consent of instructor. GRAHAM, SCHACHT.

327. **Special Topics in Twentieth-Century Journalism.** Special topics, particularly on recent developments in such areas as radio, advertising, television, and modern magazines. ½ unit. Prerequisite: Journalism 211 or consent of instructor.

329. **The Rhetoric of Journalism.** Studies in journalistic method, involving principally the analysis of structure and writing style as related to purpose. Materials are drawn from English and American journalism from the seventeenth century to the present, but emphasis is on work published in twentieth-century American newspapers and periodicals. ½ unit. Prerequisite: Journalism 211 or consent of instructor. SCHACHT.

330. **Magazine Editing.** Basic principles of editing for consumer, business, trade, and company magazines; communications theory, market analysis, editorial process, design process, production process, and distribution process as they relate to magazine publishing. ½ unit. Prerequisite: Credit or registration in Journalism 326. SCHACHT.

341. **Newspaper Management.** Principles and methods in the operation of daily and weekly newspapers; managerial problems of the editorial, advertising, circulation, and commercial printing departments; plant operation. ½ unit. Prerequisite: Credit or registration in Journalism 204.

344. **Community Newspaper Publication.** Study of weekly and small- and medium-sized daily newspapers in handling news, editorials, features, pictures, and correspondence; and in meeting business, circulation, and advertising problems. Includes one or more field trips for each student, with actual work on a small newspaper. ½ unit. Prerequisite: Journalism 212 or consent of instructor. GILMORE.

LABOR AND INDUSTRIAL RELATIONS

The Institute of Labor and Industrial Relations offers a Master of Arts and a Doctor of Philosophy in Labor and Industrial Relations. Graduate instruction is offered in trade union and management organization, in the accommodation of these organizations through the process and structure of collective bargaining, in personnel administration and employee relations, in the role of the government in legislating labor standards and labor relations, and in the formulation of public policy. These matters are studied in the context of social, economic, and political change and are analyzed with the help of theoretical and empirical formulations of economics, history, law, political science, psychology, and sociology.

Master of Arts. A student seeking admission to the Institute's master's program must meet the general entrance requirements of the Graduate College. In addition, the faculty reviews the undergraduate record of every candidate and may refuse admission to a student whose record indicates inadequate preparation. Prerequisites are courses in labor problems and statistics; course work in the various social sciences is desirable preparation for the Institute program.

Candidates for the master's degree have a choice of study programs. Program A requires eight units of graduate credit, two of which are granted for successful completion of a thesis. Program B requires ten units of course work and successful completion of both written and oral comprehensive examinations.

Doctor of Philosophy. Admission to the doctoral program is granted only to those students whose undergraduate and graduate records indicate that they are likely

to complete successfully the requirements for the Ph.D. Admission requirements are a master's degree or equivalent in labor and industrial relations or an allied field, a master's thesis or similar evidence of research competence, a grade-point average of at least 4.2, and three letters of recommendation. Prerequisites are courses in labor problems, statistics, and college algebra; first-year calculus is recommended. Minimum preparation in the social sciences is an undergraduate major in economics, history, political science, psychology, or sociology, or at least nine hours in each of two social sciences. All students entering the Ph.D. program are regarded as provisional candidates until they have passed the oral qualifying examination.

The candidate's course work is concentrated in two or more social science disciplines related to a selected area of specialization; in addition, five units of course work in industrial relations theory and methodology are required. The candidate may select one of the following four areas for specialization: (1) industrial relations systems and public policy; (2) wages, labor market behavior, and income security; (3) labor and management organizations and labor-management relations; (4) interpersonal and administrative behavior.

Students taking master's or doctoral degrees in other departments—economics, industrial administration, communications, history, political science, psychology, sociology, and others—may arrange a minor in labor and industrial relations.

Full details of the Institute program and requirements are given in the publication, *Graduate Study at the Institute of Labor and Industrial Relations*, which may be obtained by writing to the Institute of Labor and Industrial Relations.

GRADUATE FACULTY

Professors: M. Wagner (Director of the Institute of Labor and Industrial Relations), W. E. Chalmers, M. Derber, P. L. Garman, J. R. Gusfield, B. Karsh, S. B. Levine, W. McPherson, M. Rothbaum, A. F. Sturmthal, H. C. Triandis.

Associate Professors: H. Folk, W. H. Franke, C. L. Hulin, V. L. Stoikov.

Assistant Professor: P. T. Hartman.

COURSES FOR GRADUATES

418. Seminar in Industrial and Economic Sociology. Same as Sociology 418. Discussion and individual research on such topics as industrialization, labor-management relations as group relations, the interrelations of industry and community, technology and the structure of controls in industry, and the problem of a social economics. 1 unit. Prerequisite: Labor and Industrial Relations 318 or consent of instructor. Karsh, Phillips.

420. Formation of Public Policy. Same as Political Science 420. An examination of the institutional and dynamic forces that shape the making of policy and its administration in the United States; separation of powers, pressure groups, administrative and legislative procedures, and judicial activity. 1 unit. Hagan.

435. Motivation and Morale in Industry. Same as Psychology 435. Concepts and methods in the study of motivation of employees; determinants of employee attitudes and job satisfaction; modification of attitudes and morale. 1 unit. Prerequisite: Four units of graduate credit in psychology or consent of instructor. Nealey.

440. Labor Economics. Same as Economics 440. A survey of recent trends in the labor force, of real and money earnings, and of the distribution of national income. This review of recent trends in these areas is used as the basis for a critical economic analysis of contemporary English and American wage theory. 1 unit. Prerequisite: A minimum of six hours of economics.

441. **Labor Economics.** Same as Economics 441. The economic issues and implications involved in hours of work, employment and unemployment, and trade union institutionalism (the impact of the trade union upon the basic institution of a free enterprise economy). Emphasis in all cases is upon the development of appropriate public policy. 1 unit. Prerequisite: A minimum of six hours of economics.

442. **Collective Bargaining.** Same as Economics 442. The development of a theory of the continuing interactions between union and management which define and modify the role of each and the terms of employment. Appropriate social science concepts are used. Emphasis is on the negotiating process, the structure of bargaining, and such issues as wages, worker security, and management authority as well as on the interactions between the parties and the governmental process. 1 unit. Prerequisite: Consent of instructor.

443. **Problems and Practices of Labor Dispute Settlement.** Same as Economics 443. Seminar in the policies and practices of labor contract administration; comparative study of the fundamentals of grievance handling; analysis of mediation and fact-finding techniques; and special emphasis on the use of arbitration as a means of reducing industrial conflict. 1 unit. Prerequisite: Consent of instructor. McPherson.

444. **Economics of Manpower Resources.** Same as Economics 444. Emergence of the manpower resource issue; population as a resource base; the labor force; measurement and characteristics, behavior under changing income, employment, technology; women as the dynamic factor in labor force growth; problems of utilization of labor force components; intellectual resources, older workers, manual, white collar, Negro, marginal forces; issues of national manpower policy. 1 unit. Prerequisite: Consent of instructor. Parrish.

445. **Investment in Human Resources.** Same as Vocational and Technical Education 445. Activities which influence future monetary and psychic income by improving the resources in people. The investments covered include schooling, on-the-job training, medical care, migration, and the search for information on prices and incomes, with main emphasis on education. A last section covers educational planning. 1 unit. Prerequisite: An introductory course in economics and in quantitative methods.

446. **Foreign and International Labor Movements.** History and organization, economic and political policies of the major labor movements in the world; their international organizations; comparative analysis of particular problems confronting these movements; labor movements in underdeveloped areas; labor and economic development; labor under totalitarian regimes. 1 unit. Prerequisite: Consent of instructor. Sturmthal.

447. **Labor Union Organization and Administration.** Same as Economics 447. Analysis of the structure, functions, and government of the modern American trade union movement. Provides a survey of the environmental factors, objectives, and action programs with considerable emphasis on economic as well as internal institutional factors, including the roles of leaders, policy determination and execution, jurisdictional disputes, and governmental regulations. 1 unit. Prerequisite: Major in social science or consent of instructor. Garman.

448. **Problems of Personnel Management.** Same as Industrial Administration 448. An examination of the organization and administration of the personnel function in management. The course deals with the relations of personnel administration to operating departments, and the scope of business and industrial personnel services. Analytical appraisal of policies and practices in selected areas of personnel administration, such as selection and training, is carried out through case studies and direct industrial contacts. Specific consideration is given to problems up to and including placing the person on a job. 1 unit. Prerequisite: Industrial Administration 248 or equivalent, or consent of instructor.

449. Problems of Personnel Management. Same as Industrial Administration 449. A seminar and laboratory course dealing with the problems and practices encountered by personnel managers subsequent to the employment process. Students do field work in businesses and industries in the area on such topics as incentives rating, employee services, and community relations. 1 unit. Prerequisite: Labor and Industrial Relations 448 or equivalent.

450. Management and Industrial Relations. An analysis of the industrial relations function in management. Using case problems, research reports, and theoretical analyses, an examination is made of the development of the industrial relations function, alternate organizational approaches in dealing with employees and unions, the formation of labor relations policies, and management responsibilities in industrial relations. 1 unit. Prerequisite: Consent of instructor.

490. Individual Topics. A student in labor and industrial relations may register for this unit with the consent of his curriculum adviser and the adviser under whom he will perform the individual study or research. Such individual work may include special study in a subject matter for which no course is available or an individual research project, including on-the-job research in industry, which is not being undertaken for a thesis. 0 to 2 units. STAFF.

492. Readings in Labor and Industrial Relations. Readings and analysis of important works in the field of industrial relations. The course is designed to emphasize the differing but complementary approaches of several social sciences to industrial relations problems. The interdisciplinary approach is sought both through selection of readings and through the participation of various Institute staff members in discussions dealing with their special interests. 1 unit. Prerequisite: Consent of instructor.

493. Research Seminar in Labor and Industrial Relations. Systematic analysis of theories and procedures of the various social and physical sciences bearing on research in labor and industrial relations. Primary emphasis is on the process of integrating the approaches and techniques of the various social sciences with respect to the study of problems in labor and industrial relations as met in practice in management, the union, and government service, as well as in teaching and research in the field. 1 unit. Prerequisite: Major in social sciences or consent of instructor. DERBER, FRANKE.

494. The Major Theorists of Industrial Relations. An integrated analysis of the principles of labor relations through the study of the works of the major theorists and their critics. 1 unit. Prerequisite: Consent of instructor. DERBER.

495. Application of Theory to Contemporary Problems in Labor and Industrial Relations. A seminar for advanced graduate students in the application of social science and industrial relations theory and research methodology to selected contemporary problems. Seminar discussions focus on work developed by the seminar members. 1 unit. Prerequisite: Labor and Industrial Relations 493 and 494, or consent of instructor.

496. The Evolution of Labor-Management Relations in America. Analysis and interpretation of the development of labor-management relations at the plant and industry levels from the stages of master and servant and master and journeyman in colonial times to the stage of constitutional government and industrial democracy in the present day. 1 unit. Prerequisite. Graduate standing in labor and industrial relations or consent of instructor. DERBER.

498. Analysis of Organizations in Industrial Relations. An intensive analysis of organizational behavior, with the main focus upon the theory of organizations as social institutions. Concepts are drawn from the various social sciences and applied to the principal organizations concerned with industrial relations. The internal dynamics of unions, managements, and government agencies are examined,

with special reference to decision-making processes, and are related to the interactions among them. 1 unit. Prerequisite: Consent of instructor. LEVINE.

499. **Thesis Research.** For all students writing theses in labor and industrial relations. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

318. **Industry and Society.** Same as Sociology 318. Introduction to the sociology of economic institutions; selected problems of technological change and industrialization; corporate organization and trade union structure; human relations in industry and the changing bases of managerial authority; changing consumption patterns and the redefinition of work and leisure. ½ or 1 unit. Prerequisite: Six hours of sociology including one of the following: Sociology 218, 223, 300, 322, 326, or consent of instructor. KARSH.

321. **Industrial Social Systems, I.** Same as Industrial Administration 321. Particular forms of individual and group behavior in organizations within the constraints of the economic, social, technological, and physical environment; the relations between union and management; the interdependency of these factors with the decisions managers make. ½ to 1 unit. Prerequisite: Industrial Administration 210; Psychology 100; Psychology 201 or consent of instructor.

342. **Economics of Social Security.** Same as Economics 342. A critical analysis of the economic issues and problems involved in our legislative efforts to reduce the economic risks of unemployment, old age dependency, and industrial injuries. ½ or 1 unit. Prerequisite: Economics 103 or 108.

344. **The Law and Labor.** Same as Economics 344. An economic analysis of the problems and issues arising out of the legislative and judicial efforts to define the rights, duties, and responsibilities of labor organizations and management in the field of industrial relations. ½ or 1 unit. Prerequisite: Economics 103 or 108; Economics 240.

347. **Labor Law, I.** Same as Law 347. The law of industrial relations with special emphasis on recent cases and legislation; the establishment of the collective bargaining relationships; strikes, boycotts, and picketing; Federalism and labor relations. 1 unit.

355. **Industrial Social Psychology.** Same as Psychology 355. Social psychological research and theory applied to industrial problems. Emphasis upon interaction and communication theory, role theory, leadership theory, motivational and perceptual theory, and group structure theory as an aid to understanding and analyzing industrial problems. ½ or 1 unit. Prerequisite: Psychology 255 or Labor and Industrial Relations 357. TRIANDIS.

357. **Psychology of Industrial Conflict.** Same as Psychology 357. An analysis, in terms of the behavior of individuals, of the causes and possible solutions of industrial conflict. ½ or 1 unit. Prerequisite: Psychology 100 or equivalent. Offered in special interest of industrial relations, commerce, and engineering students. HULIN.

360. **Employee Benefit Plans.** Same as Finance 360. An analysis of the economic and financial issues involved in designing and administering employee benefit plans; major emphasis is given to group life, disability income, and medical care plans, and to "qualified" pensions, and profit-sharing plans for regular employees; some attention is given to special, supplementary plans for the executive employees. ½ to 1 unit. Prerequisite: Finance 260, Economics 240, or Industrial Administration 351; or consent of instructor.

365. **Government and Labor.** Same as Political Science 365. Critical analysis of the relationship between group pressures on government and public policy affecting

labor; role of administration in formation of policy; problems and experience of federal agencies operating in the labor fields. ½ or 1 unit. Prerequisite: Political Science 150 or 191.

LANDSCAPE ARCHITECTURE

The Department of Landscape Architecture offers work leading to the Master of Landscape Architecture degree. Students applying for admission must have a grade-point average of at least 3.75.

The prerequisite for graduate work in landscape architecture is a bachelor's degree in landscape architecture or related fields of study. Those students whose undergraduate major is not substantially equivalent to the degree in landscape architecture conferred by the University of Illinois must expect to complete prerequisite courses before taking advanced work in landscape architecture.

To qualify for this degree, a student must complete (1) at least six units of graduate credit in required courses in landscape architecture, (2) at least two additional units to be chosen from the following fields: architecture, art, botany, civil engineering, forestry, geography, geology, horticulture, recreation, or urban planning. Required credit for the thesis is specified by the department.

GRADUATE FACULTY

Professors: W. G. Carnes (Chairman of Department), W. M. Keith.

Associate Professor: T. C. Hazlett.

Assistant Professors: A. J. Rutledge, D. L. Walker, Jr.

COURSES FOR GRADUATES

436. **Advanced Landscape Design.** Landscape design of large private, semipublic, and public properties. 1 to 2 units. Prerequisite: Bachelor's degree in landscape architecture.

447. **Advanced Landscape Construction.** Advanced investigations and applications of new techniques of construction to landscape development. ½ or 1 unit. Prerequisite: Landscape Architecture 243, 244, bachelor's degree in landscape architecture, or consent of instructor.

457. **Advanced Planting Design.** Theory and application of planting design in relation to private, semipublic, and public properties. ½ or 1 unit. Prerequisite: Bachelor's degree in landscape architecture.

477. **Theory and Application of Landscape Design.** Advanced studies in the physical and ecological bases of landscape, aesthetic principles, and landscape planning. ½ or 1 unit. Prerequisite: Landscape Architecture 337 or consent of instructor.

487. **Seminar.** ½ or 1 unit.

499. **Thesis Research.** ½ to 2 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

337. **Advanced Landscape Design, I.** Advanced problems of landscape design for urban and institutional situations. 1 to 1½ units. Prerequisite: Landscape Architecture 236.

338. **Advanced Landscape Design, II.** Terminal project; comprehensive landscape architectural development. 1 to 2 units. Prerequisite: Landscape Architecture 337.

LATIN-AMERICAN STUDIES

Graduate minors in Latin-American studies are administered by the Director of the Center for Latin-American Studies.

Candidates for the master's degree who elect a minor in Latin-American studies must complete two units from the courses prescribed by the Center for Latin-American Studies. Doctoral candidates who elect a minor in this area must complete four units for a sole minor, or two units for a split minor. Courses must be taken in at least two departments; lists of courses fulfilling the minor are available from the Center.

Students in technical and professional colleges and schools of the University who seek knowledge of Latin-American affairs, culture, and languages are invited to consult with the Director of the Center for Latin-American Studies, 1207 West Oregon Street, Urbana, or with their advisers, in order to develop programs suited to their individual needs. Such a program may often be adopted as a special minor under existing regulations if the student so desires. These courses are of particular value to students who intend to carry on technical or professional work in the Latin-American area for the government, private business, publications, or religious organizations.

LAW

The College of Law offers a program of graduate work leading to the Master of Laws (LL.M.), Master of Comparative Law (M.C.L.), and Doctor of the Science of Law (J.S.D.).

A student whose undergraduate study in law has been in systems based on the Anglo-American common law is eligible to apply for candidacy for the Master of Laws or Doctor of the Science of Law. A foreign lawyer whose prior law study has been in a system which is not based on the Anglo-American common law may, in exceptional cases, be admitted to candidacy for the Master of Laws or Doctor of the Science of Law, or such foreign lawyer may apply for candidacy for the Master of Comparative Law. The Master of Comparative Law program is designed to develop facility in the comparative method and to prepare a foreign lawyer to deal knowledgeably with Anglo-American problems.

For admission, an applicant must have received a first degree in law from the University of Illinois or from a law school approved by the University, and must present evidence of ability to do satisfactory work at the graduate level. Normally no student is admitted as a candidate for the Master of Laws unless he has a grade-point average of 4.0 in all law work previously undertaken. A student who is a candidate for the degree of Doctor of the Science of Law is normally required to have a grade-point average of 4.0 in all law work previously undertaken, and also to present evidence that he has the ability to do independent research; the latter requirement may be met by the submission of satisfactory legal writing done while the applicant was a candidate for the Doctor of Law (or equivalent degree), or subsequent to the receipt of that degree.

One academic year in residence is required of a candidate for an advanced degree. The programs consist of course work and research which have been approved by the committee on graduate study of the College of Law, comprising at least eight units of graduate work of which at least two for the master's degree and four for the doctor's degree must be in research. In addition to the course work and research, a thesis is required. For the master's degree, the thesis may be completed during the year in residence. For the doctor's degree, the thesis must be submitted not less than one year nor more than five years after the completion of the residence requirements, and the candidate must pass an oral examination before a committee of the faculty. The candidate for the Master of Laws must secure an average of 3.5 in his graduate law courses; the candidate for the Doctor of the Science of Law, an average of 4.0.

Details of the programs may be obtained from the Dean of the College of Law, 209 Law Building.

GRADUATE FACULTY

Professors: J. E. Cribbet (Dean of College of Law), C. H. Bowman, K. S. Carlston, R. G. Cohn, G. T. Frampton, P. H. Hay, W. R. LaFave, J. O'Connell, S. J. Plager, C. W. Quick, V. J. Stone, J. N. Young.

Associate Professors: D. C. Baum, M. W. Benfield, R. W. Findley, S. B. Goldberg, H. D. Krause, P. B. Maggs, R. Reisner, H. Semmel.

Assistant Professors: E. J. Kionka, J. H. McCord.

COURSES FOR GRADUATES

400. Seminar: Legal Education. Problems in legal education, curricula, teaching materials, methods of teaching, the place and function of individual courses in the law school program. ½ unit.

499. Thesis Research. ½ to 3 units.

PROFESSIONAL COURSES

301. Contracts A. Offer and acceptance, consideration, seals, Statute of Frauds. 1 unit (for recommended M.C.L. candidates only). Benfield, Hay, Maggs.

302. Contracts B. Third-party beneficiaries, assignment, conditions, impossibility, anticipatory repudiation, and discharge; contract and quasi-contract distinguished, and measure of damages for each. 1 unit (for recommended M.C.L. candidates only). Prerequisite: Law 301. Benfield, Hay, Maggs.

303. Torts A. Basic course in civil wrongs, including intentional infliction of emotional harm, right of privacy, libel and slander, and unfair commercial practices. ½ unit (for recommended M.C.L. candidates only). Krause, O'Connell, Quick.

304. Torts B. Basic course in civil wrongs, including negligence, liability without fault, tort liability of owners and occupiers of land, and the impact of insurance on tort liability. 1 unit (for recommended M.C.L. candidates only). Prerequisite: Law 303. Krause, O'Connell, Quick.

305. Judicial Remedies. Introduction to civil procedure, common-law forms of action, extraordinary legal remedies, nature of equity jurisprudence, equitable remedies, abolition of the forms of action, fusion of law and equity, statutory remedies. 1 unit (for recommended M.C.L. candidates only). Marshall, Semmel, Stone.

307. Property A. The concept of property; acquisition of private property; recognized property interest (personal, real, estates in land). 1 unit (for recommended M.C.L. candidates only). Cribbet, Findley, Plager.

308. Property B. Gratuitous transfer of property interests; commerical transfers (sale, lease); the use of property. 1 unit (for recommended M.C.L. candidates only). Prerequisite: Law 307. Cribbet, Findley, Plager.

309. Criminal Law. The sources and purposes of the criminal law; the meaning of criminal responsibility; the characteristics of particular crimes. 1 unit (for recommended M.C.L. candidates only). Bowman, LaFave.

310. Constitutional Law. The apportionment of governmental power between the United States and the states, and the limitations on power resulting from the contract, equal protection, and due process clauses. 1 unit (for recommended M.C.L. candidates only). Goldberg, LaFave, Reisner.

320. **Business Associations.** The fundamental legal consequences to principals, agents, and third parties of association in various types of business transactions and in various forms of business enterprise. 1 unit (for recommended M.C.L. candidates only). Baum, Frampton.

322. **Commercial Law, I.** A study of the major problems involved in the exchange of goods and commercial paper with special emphasis upon the history and interpretation of the Uniform Commercial Code as it affects commercial transactions. 1 unit. Benfield.

323. **Administrative Law.** The functions of administrative tribunals in federal, state, and municipal government, the procedure before such administrative tribunals, and judicial relief from administrative decisions. 1 unit. Cohn.

324. **Corporations.** Promotion and organization of corporations and the rights and liabilities of officers, directors, and shareholders. 1 unit. Baum, Frampton.

326. **Evidence.** Principles governing the competency of witnesses and the admissibility of evidence. 1 unit. Marshall, Quick.

328. **Income Taxation.** A study of federal income tax problems relating to business and investment transactions. Subjects treated include the concept of taxable income; allowable deductions; accounting for income and deductions; capital gains; partnership operations; corporate distributions and reorganizations; and tax procedure. 1 unit. McCord, Young.

329. **Decedents' Estates and Trusts.** A study of the gratuitous disposition of property by intestacy, by will, and by inter vivos gifts and trusts, including administration of decedents' estates and trusts. 1 unit. Kionka, Plager.

330. **Restitution.** Contractual and quasi-contractual remedies (both legal and equitable) available because of duress, fraud, innocent misrepresentation, mistake, illegality, and economic compulsion in the formation and discharge of contracts and other transactions. 1 unit.

331. **Legislation.** A study of legislative policies and procedures, of legislation as a source of law, of types of statutes and their structure, and of the problems of interpretation. 1 unit. Cohn.

333. **Persons.** Creation and dissolution of the family unit and relations between members thereof; marriage, separation, divorce, rights and duties of spouses and means for their enforcement; legal capacity of wife and infant. ½ unit. Krause.

334. **Criminal Law Administration and Procedure.** Problems in the administration of the criminal law; a study of criminal procedure from arrest to the end of the prosecution in a court of review, with emphasis on procedure as a device for social regulation, and including an appraisal of aims and workings of probation, parole, and executive clemency. ½ unit. Bowman, Goldberg, LaFave.

335. **Trials and Appeals.** Ligation from process through appeal, excluding pleading and evidence. 1 unit. Stone.

337. **Commercial Law, II.** Selected problems under the Uniform Commercial Code in modern commercial banking law and practice. ½ unit. Benfield.

338. **Insurance.** Personal and property insurance; formation of the insurance relation; concealment, warranties, representations; insurable interest; conditions; subrogation; waiver and estoppel; incontestability; the respective interests of the beneficiary, insured, insurer, assignee, and creditor, and facts constituting maturity in life, accident, fire, theft, liability, and collision policies. ½ unit.

339. **Conflict of Laws.** Problems from conflict of laws involving jurisdiction of courts; judgments; torts and workmen's compensation; contracts; property; family law; administration of estates; business organizations; governmental activities. 1 unit. Hay.

340. **Local Government Law.** History and functions; judicial, legislative, and administrative control; creation, dissolution, and changes in structure; law-making powers; finance; planning and development functions; regulatory powers; contracts; tort liabilities; federal-local and inter-local relations. 1 unit. BAUM.

341. **Oil and Gas.** Nature of the property interests in oil and gas; legal interests created by oil and gas leases; validity of leases; the habendum clause; the drilling and rental clauses; transfer of oil and gas interests; rents and royalties; public regulation of the production of oil and gas. 1 unit. FINDLEY.

342. **Mortgages.** A study of real estate mortgages. 1 unit. FINDLEY.

343. **Admiralty.** Admiralty and maritime jurisdiction; the maritime lien; carriage of goods; salvage; general average; collision; claims of seamen; limitation of liability; application of state law; sovereign responsibility; choice of law. 1 unit.

344. **Creditors' Rights.** Remedies of the delinquent debtor and his creditors under the Bankruptcy Act; liquidation and rehabilitation; exercises in bankruptcy procedures. 1 unit. BOWMAN.

345. **Civil and Political Rights.** A study of some of the basic problems in the relation of the individual to government and in the protection of rights of minority groups. ½ unit. REISNER.

346. **Future Interests.** A study of the validity and effect of gratuitous dispositions of assets in which enjoyment is postponed, restrained, or long continued; classification of future interests; construction; powers of appointment; rule against perpetuities and related restrictions. 1 unit.

347. **Labor Law, I.** Same as Labor and Industrial Relations 347. The law of industrial relations with special emphasis on recent cases and legislation; the establishment of the collective bargaining relationship; strikes, boycotts, and picketing; Federalism and labor relations. 1 unit. GOLDBERG.

348. **International Law.** The nature, sources, and subjects of international law, its place in the control of international society, and an examination of the law of jurisdiction, territory, recognition, and succession of states, rights and immunities of states in foreign courts, diplomatic immunities, treaties, protection of citizens abroad, settlement of international disputes, war and neutrality, the United Nations, and the International Court of Justice. 1 unit. CARLSTON.

349. **State and Local Taxation.** Proper and improper purposes of taxation; the general property tax and its administration; taxpayers' remedies; excise taxes on business concerns and transactions; problems of jurisdication to tax. ½ unit. YOUNG.

351. **Jurisprudence.** The place of law in society, the goals and methods of law, the nature of law, relation of law and social science. 1 unit. CARLSTON.

352. **Taxation of Gratuitous Transfers.** Various tax problems encountered in the distribution of wealth by inter vivos and testamentary disposition, including a study of federal estate and gift taxes, the Illinois inheritance tax, problems in the assignment of income, and federal income taxes upon estates and trusts. Attention is given to tax planning in the distribution of wealth. ½ unit. KIONKA, YOUNG.

353. **Corporation Finance and Securities.** Drafting provisions of preferred shares; counseling problems requiring written memoranda on the application of state and federal securities laws to the marketing of securities and on the effect of statutes and decisions on distribution of dividends, redemption and purchase of shares, and recapitalization, reorganization, and dissolution of corporations. ½ unit. FRAMPTON, MCCORD.

355. **Trade Regulation.** Antitrust law, control of restrictive business practices, mo-

nopoly, unfair competition, trademarks, price discrimination, resale price maintenance, Federal Trade Commission. 1 unit. CARLSTON.

356. **Federal Courts.** The federal judicial system; relationship of federal and state law; jurisdiction of federal courts and their relation to state tribunals. 1 unit. STONE.

358. **Modern Social Legislation.** A focus, for illustrative purposes, on the traffic victim and his claim for compensation: the present common-law method compared with various schemes of social insurance; problems of coordinating, as well as comparing, any such scheme of social legislation with the tort system and with other social and private insurance arrangements such as workmen's compensation, Blue Cross, etc. Attention is given to both broad questions of social policy and technical drafting problems. 1 unit. O'CONNELL.

359. **Legal History.** The development of the common-law system in England and America: the origin and growth of English legal thought, legal doctrine, and legal institutions; the history of real property, contracts, and torts; the origin and development of courts, legislation, equity, the doctrine of precedent; the evolution of the legal profession; the reception of the common law in America. 1 unit.

365. **Tax Problems.** Selected problems relating to partners and partnerships, corporations and shareholders. ½ unit. MCCORD, YOUNG.

369. **Soviet Law.** An examination of Soviet conceptions of the role of law as evidenced both in theory and in practice; emphasis on highlights of Soviet law, with comparison to the common-law and civil-law traditions; study of Soviet court and legislative materials to determine characteristic pattern with respect to: constitution and administration, the relation of the individual with the state and with society; legal regulation of property and productive institutions, private relationships, and international law. 1 unit. MAGGS.

370. **Labor Law, II.** Advanced problems in the law of industrial relations with particular emphasis on the negotiation and administration of the collective bargaining agreement; the relation between the individual and the union. ½ unit. Prerequisite: Law 347 or consent of instructor. GOLDBERG.

371. **Seminar in Selected Legal Problems.** An introduction to the methods and materials of legal research. The work of the course consists of the discussion of selected topics. In addition, each student investigates a topic approved by the instructor. The results of the investigation are presented orally to the class and submitted in writing to the instructor. The several sections are oriented to different subject matter areas. Credit may be earned in more than one section. ½ unit.

372. **Problems in Estate Planning.** Selected problems in the planning of estates which serve to integrate the basic materials in property, trusts, wills, income, estate, and gift taxation. ½ unit. MCCORD, YOUNG.

382. **Comparative Law.** A comparative analysis of the three basic institutions of private law: tort, contract, and property. The solutions arrived at in the common-law system are contrasted with the solutions arrived at in the civil-law system and in the Soviet legal system. 1 unit. KRAUSE.

383. **Law and Society.** An examination of some important ideas concerning the nature of law and the role of law in society. 1 unit. REISNER.

387. **International Economic Organizations.** A survey of the principal international economic organizations such as GATT, OECD, ECE, and international monetary and investment institutions (IMF, IBRD, AID); an intensive study of the European Common Market, particularly of its laws relating to trade barriers, establishment of companies, and antitrust; United States legislation in the field of international trade (Trade Expansion Act of 1962). 1 unit. HAY.

399. Research in Special Topics. Individual research on a special problem selected in consultation with the instructor. ½ or 1 unit.

LIBRARY SCIENCE

The purpose of the Graduate School of Library Science is to prepare young men and women for careers as professional librarians in all types of libraries. Programs of study may be followed leading to the master's degree, certificate of advanced study in librarianship, and the doctor's degree in library science.

Master of Science. Applicants for admission to the Graduate School of Library Science must first be admitted to the Graduate College.

In addition to the Graduate College requirements, applicants to the Graduate School of Library Science must meet the following requirements: (1) a minimum grade-point average of 3.75 for the last sixty hours of academic work completed; (2) one sequence (two terms) of courses at the college level in each of the three main fields of science, social science, and humanities, and a total of four such sequences in all; (3) a major subject in any field of study, comparable to the undergraduate major at the University of Illinois (at least twenty-four semester hours); (4) two years of college-level study of any foreign language. This may be either two years of study of one language or one year of each of two languages.

A candidate for the master's degree must complete a prescribed program of undergraduate courses. This requirement may be met by one of the following: (1) completion of a minimum of sixteen semester hours of library science with a grade-point average of at least 4.0 in an institution approved by the Graduate School of Library Science; (2) completion of the preparatory sequence of four courses, Library Science 201, 204, 255, and 258, in the Graduate School of Library Science with a grade-point average of at least 4.0. Exemption from one or more of these courses may be secured by a satisfactory score on a comprehensive examination which is offered on the day preceding the opening of registration each semester and summer session. There is a special offering of these four courses each eight-week summer session, enabling beginning students to complete the entire preparatory sequence before taking regular graduate library science courses in the fall semester. This makes possible the most efficient and satisfactory program, and students are urged to plan accordingly.

At least two semesters in residence—or the equivalent—are required to earn the master's degree, in addition to attendance in preparatory courses. In this period, eight units of graduate study should be completed. Each student's program of study, adapted to his particular needs and purposes, is planned in consultation with an adviser at the time of original registration and thereafter. Students who have completed their undergraduate library science requirement in institutions other than the University of Illinois are required to take the comprehensive examination and to complete Library Science 405, 407, and 411 or 412, and one of the 300-level literature courses. No thesis is required.

Students interested in the Advanced Master's program, the Certificate of Advanced Study in Librarianship, and the Doctor of Philosophy degree should write to the Director of the Graduate School of Library Science, 329 Library.

GRADUATE FACULTY

Professors: R. B. Downs (Dean of Library Administration), H. Goldhor (Director of the Graduate School of Library Science), G. G. Garrison, Frances B. Jenkins, Winifred C. Ladley, R. E. Stevens.

Associate Professor: M. Alice Lohrer.

Assistant Professors: D. E. Carroll, Kathryn L. Henderson, Cora E. Thomassen.

COURSES FOR GRADUATES

402. **Studies in Reading.** Designed to acquaint students with the major areas of investigation and interest in reading. Special attention is given to studies of reading interests and habits of children, youth, and adults. Class discussions are devoted to analysis of various studies and their implications for library service and classroom teaching. 1 unit. LADLEY, LOHRER.

405. **Library Administration.** Designed to supply knowledge of the internal organization of libraries and of the principles of library administration. Emphasis is on comparison of the conditions found in the several kinds of libraries and on applications of the general theory of administration. 1 unit. FIELD.

406. **Library Service to Children and Young Adults.** The role, problems, and needs of library service in the elementary and secondary school fields, and of library work with children and young adults in the public library. 1 unit. Credit is not given for Library Science 406 in addition to credit in Library Science 307. Prerequisite: Library Science 204 or 405. LADLEY, LOHRER.

407. **Cataloging and Classification, I.** The theory, practice, and application of the principles of cataloging and classification. Emphasizes subject cataloging and complex types of entry. Problems provide experience with the Decimal Classification and Library of Congress Classification and Library of Congress subject headings. 1 unit. HENDERSON.

408. **Cataloging and Classification, II.** The theory, practice, and application of the principles of cataloging and classification. Takes up the cataloging and classification of special types of materials, including maps, music, films, slides, phonograph records, and incunabula and other rare items. Includes some discussion of the administrative problems of a cataloging department. 1 unit. Prerequisite: Library Science 407. HENDERSON.

409. **Communication Roles and Responsibilities of Libraries.** Mass media of communication are considered in terms of their relations with modern library services; media organization, content, and research are reviewed; problems of intellectual freedom are considered as an aspect of communications behavior; and the potential role of electronic devices in library activities now and for the future is discussed. 1 unit.

410. **Adult Education and Libraries.** The literature, history, and problems of adult education in the United States are presented in relation to the role of the library as an educational agency. Students study organization for adult education in the community and become familiar with the significant methods and materials used in a variety of educational programs. 1 unit.

411. **Reference Service in the Humanities and Social Sciences.** Detailed consideration of the bibliographical and reference materials in various subject fields, with training and practice in their use for solving questions arising in reference service. 1 unit. ALLEN, STEVENS.

412. **Science Reference Service.** Study of representative reference sources in pure and applied science. Designed to acquaint the student with typical problems encountered in providing and servicing scientific reference materials. 1 unit. JENKINS.

424. **Government Publications.** The nature and scope of American and British government publications; the problems of organization arising from their form and from the methods of their production and distribution. 1 unit. Prerequisite: Library Science 411 or 412, or consent of instructor. FIELD.

427. **Resources of American Research Libraries.** Aims to acquaint students with the distribution and extent of American library resources for advanced study and research; spatial and financial aspects of library resources; methods of surveying library facilities; growth and use of union catalogs and bibliographical centers;

interinstitutional agreements for specialization of collections and other forms of library cooperation; and ways and means of developing research collections in special subject fields. 1 unit. STEVENS.

428. **Library Buildings.** A study of the library's physical plant in the light of changing concepts and patterns of library service. Present-day library buildings, both new and remodeled, are analyzed and compared with each other as well as with buildings of the past. The interrelationship of staff, collections, users, and physical plant is examined in detail. Class discussion is supplemented by visits to new libraries and conference with their staffs. 1 unit. Prerequisite: Library Science 405 or consent of instructor. GARRISON.

429. **Information Storage and Retrieval.** Analyzes the problems which confront libraries and library users as a result of the growth of literature; reviews the various systems for storing and retrieving information; introduces the underlying models and basic types of equipment for both traditional and non-conventional systems; emphasizes practical applications in libraries. 1 unit. Prerequisite: Library Science 405; consent of instructor. CARROLL.

430. **Advanced Reference.** Designed to enable the student to utilize the varied resources of a large research library. Deals with the method of analyzing and solving bibliographic problems such as arise in scholarly libraries and in connection with research projects. 1 unit. Prerequisite: Library Science 424 or consent of instructor. ALLEN.

431. **Books and Libraries in the Ancient and Medieval World.** The development of writing and of the book in ancient and medieval times; book collecting and the growth of libraries from earliest times to the discovery of printing. 1 unit. STEVENS.

432. **Books and Libraries Since the Renaissance.** Same as Communications 432. The development of printing since the fifteenth century, and its effect on the nature and use of the book; the growth of national, college and university, public, and other libraries in Europe and America from the Renaissance to the present day. 1 unit. STEVENS.

433. **Advanced Subject Bibliography.** A study of the literature, information sources, and reference aids in various specialized fields of knowledge, identified as different sections of this course, from the point of view of their use by librarians. No student may take more than two different sections for credit toward a degree: (a) biological sciences, (b) chemistry, (c) education and psychology, (d) engineering, (e) law, (f) maps, (g) music, (h) mathematics, (i) Slavic bibliography. ½ unit. Prerequisite: Consent of instructor. STAFF.

434. **Library Systems.** Considers the development of library systems, with special reference to public libraries as a norm for the development of library services: library standards, the growth and development of county and regional libraries, the role of the state library and of federal legislation are among the topics treated in detail. 1 unit. Prerequisite: Library Science 405 or consent of instructor.

436. **Development of the Library Catalog.** The history and philosophy of classification schemes and cataloging codes, and comparative study of present-day cataloging practices. 1 unit. Prerequisite: Library Science 407, 408, or consent of instructor. FIELD.

438. **Administration and Use of Archival Materials.** Administration of archives and historical manuscripts, with emphasis on the processing and research use of archival materials. 1 unit. Prerequisite: Consent of instructor. BRICHFORD.

439. **Medical Literature and Reference Work.** Considers representative reference and bibliographical aids in medical sciences. Problems provide experience with typical medical reference sources (only at the University of Illinois Medical Center in Chicago). S; 1 unit. Prerequisite: Consent of instructor.

440. **Problems in Bibliographical Method.** Same as English 450. Work on individual bibliographical problems, with a study of bookmaking, manuscripts and their relation to the printed text, editorial problems, and literary forgeries. 1 unit. Prerequisite: Consent of instructor.

441. **History of Children's Literature.** Interpretation of children's literature from the earliest times to the present, with recognition given to the impact of the changing social and cultural patterns on books for children and on children's reading. Attention is given to the early printers and publishers of children's books and to magazines for children in the nineteenth century. 1 unit. LOHRER.

442. **Seminar in Library Materials for Children and Young Adults.** Advanced study of the criteria for the evaluation of books, films, and recordings. Each student completes a project on a given theme or subject, involving extensive and critical reading, viewing, and listening. 1 unit. Prerequisite: Library Science 303 or 304, and Educational Psychology 211, or consent of instructor. LADLEY.

443. **Contemporary Book Publishing.** Survey of twentieth-century book publishing, particularly in America, placing it in an economic, social, and literary context. Emphasis is on production, technological developments, economic structure, methods of distribution and promotion, and book publishing as an art. 1 unit. BLUM.

COURSE FOR ADVANCED GRADUATES

450. **Advanced Studies in Librarianship.** Directed and supervised investigation of selected problems in library resources, reference service, research libraries, reading, public libraries, or school libraries. ½ to 2 units. Prerequisite: Fifth-year degree in library science or consent of director. STAFF.

462. **History of Education for Librarianship.** A study of the origin and development of library science education in this country and abroad; emphasis is placed on the major events and activities which led to the present status of library school programs. 1 unit. Prerequisite: Master of Science in Library Science or consent of instructor.

463. **Current Developments in Technical Services.** An examination of changing policies and procedures in the administration of acquisitions, cataloging, binding, photographic reproduction, and related areas. 1 unit. Prerequisite: Master of Science in Library Science or consent of instructor. STEVENS.

465. **Librarianship and Society.** Analysis of the role and functions of libraries in the twentieth century; the changing characteristics of information and knowledge are viewed as major determinants of libraries' relations to society. 1 unit. Prerequisite: Master of Science in Library Science or consent of instructor.

468. **Teaching Methods and Special Problems in Contemporary Library Schools.** Designed for those interested in preparing for the teaching of library science at the graduate level. Current library school programs and the various methods of instruction are analyzed as to effectiveness and application for the major areas of library science content; attention is given to the process of curriculum construction to meet the changing needs of the profession and to the experience of other professions. 1 unit. Prerequisite: Library Science 462 or consent of instructor. GOLDHOR.

469. **Principles of Research Methods.** Designed for persons planning to engage in research. The course reviews significant investigations in the library field, and considers the use of hypotheses, the conduct of experiments, the nature of proof, and the employment of statistical methods, with a view to helping students develop their dissertations. Required for doctoral candidates. 1 unit. Prerequisite: Knowledge of the principles of statistics, Master of Science in Library Science, or consent of instructor. GOLDHOR.

499. Thesis Research. Individual study and research. Section A: M.S. candidates; 0 to 2 units. Section B: Ph.D. candidates, 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Literature of the Humanities and Social Sciences. This course is designed to build a knowledge of the scope and significant characteristics of the several fields comprising the humanities and social sciences through a systematic study of names, trends, and outstanding classic and current materials in each. Attempts to identify general basic knowledge for each field which is essential for the librarian in selection of materials and reading guidance. 1 unit. CARROLL.

302. Literature of the Sciences. An introduction to the scope and significant characteristics of the literature of science, to modern concepts and representative literary works in each of the major fields of pure and applied science. Designed to give an insight into the content of the scientific disciplines and of their role in modern society. Selected readings and films acquaint students with representative material in the field. 1 unit. Prerequistie: Library Science 204, 258, or consent of instructor. JENKINS.

303. Library Materials for Children. The selection and use of library materials for children in public and school libraries, according to the needs of the child in his physical, mental, social, and emotional development and the purposes of the elementary school program. The student becomes acquainted with the standard book selection aids for children and with all types of printed and audio-visual materials, and develops the ability to select and describe children's library materials according to their developmental uses. Credit is not given for Library Science 303 in addition to credit in Library Science 307. ½ or 1 unit. LADLEY, LOHRER, THOMASSEN.

304. Library Materials for Young Adults. The selection and use of library materials for the young adult in school and public libraries and community organizations. The course aims to develop the ability to select and evaluate a wide variety of reading materials from standard bibliographies for the adolescent according to his personal and school needs. Credit is not given for Library Science 304 in addition to credit in Library Science 307. ½ to 1 unit. LOHRER, THOMASSEN.

307. Library Materials and Services for Children and Young Adults. A nonspecialist's view of the materials and services involved in work with children and young adults, including a brief survey of print and nonprint materials for children and young people, and basic guidelines for library services to them. Credit is not given for Library Science 307 in addition to credit in Library Science 303, 304, 309, or 406. 1 unit. Prerequisite: Consent of instructor.

308. Audio-Visual Services in Libraries. Designed to acquaint students with the typical audio-visual programs and responsibilities of libraries. Group activities stress, through presentation and evaluation, the use of materials and related equipment necessary for film, radio and television, exhibit and other programs of libraries. The practices of audio-visual departments in libraries are reviewed and evaluated. 1 unit. THOMASSEN.

309. Storytelling. Fundamental principles of the art of storytelling including techniques of adaptation and presentation for children of various ages. Content and sources of materials; story cycles; methods of learning; practice in storytelling; planning the story hour for the school and public libraries, for recreational centers, for the radio, and for television. Open to undergraduates and non-Graduate School of Library Science students. Credit is not given for Library Science 309 in addition to credit in Library Science 307. ½ or 1 unit. LADLEY.

LIFE SCIENCES

(Including Biology, Botany, Entomology, Microbiology, Physiology and Biophysics, and Zoology)

The School of Life Sciences is a unit of the College of Liberal Arts and Sciences and includes the Departments of Botany, Entomology, Microbiology, Physiology and Biophysics, and Zoology. Study programs leading to the graduate degrees of Master of Science and Doctor of Philosophy exist in each of the departments and are described in detail in the following pages. Interdepartmental study programs leading to advanced degrees in cell biology and virology, and developmental biology, are administered within the School. The School also participates with other departments of the University in offering the Ph.D. program in genetics (see page 195) and with the Department of Chemistry and Chemical Engineering in offering a program in biophysical chemistry (see page 103). Applicants who desire to enter any of the graduate study programs are usually required to have earned a grade-point average of at least 4.0 for their last sixty hours of undergraduate work. In certain programs, applicants with a grade-point average between 3.5 and 4.0 are considered by a special committee.

Support for graduate training is available in the form of teaching or research assistantships, University fellowships, or trainee fellowships. Prospective students may obtain application forms and relevant information for departmental study programs from the executive officer of the appropriate department, or for interdepartmental study programs from the Director of the School of Life Sciences.

INTERDEPARTMENTAL STUDY PROGRAMS

Master of Science in the Teaching of the Biological Sciences and General Science. This degree is offered with the completion of the fifth year in the teacher-education curriculum in biological and general science. The degree is primarily intended for but not restricted to certified teachers of biology and general science in junior high school, high school, and junior college. For admission to this degree program, students must have a grade-point average of at least 3.5. See pages 45 and 46.

Candidates for the Master of Science in the Teaching of the Biological Sciences and General Science must earn four units in biological sciences, two units in education, and two units in electives. The two units in education must include: History and Philosophy of Education 304 and 305, one unit; and Educational Psychology 311 and 312, one unit. Electives may be in the biological sciences, in education, or, in exceptional cases, in other fields. A course in biological chemistry is strongly advised. The adviser for candidates for this degree is Professor Joseph Larsen, 318c Morrill Hall.

Master of Science in Biology. The program of study leading to the master's degree in biology is designed for individuals who (1) wish additional training at the master's level for professional proficiency in teaching or research, (2) desire to continue to the Ph.D. degree, possibly in one of the programs sponsored by the School of Life Sciences, or (3) do not wish to limit their training to a single area of biology. Students whose interests fall into a specific area of biology should apply directly to the relevant department or program.

Admission to this curriculum requires a grade-point average of 4.0 or higher. Applicants whose grade-point average is less than 4.0 but 3.75 or higher will be considered on an individual basis. Those in the latter group should outline their educational objectives in a three hundred-word essay and should, in addition, submit three letters of recommendation. Although no specific undergraduate courses are required for admission to this curriculum, a year of physics, a course in organic chemistry, and a semester of calculus or statistics must be completed before a degree is granted. Preference is given to those applicants who have already completed most of these courses.

Candidates for the degree are advised to obtain a broad, basic training in biology and are examined in aspects of cellular, organismic, and population biology. Of the eight units required for the degree, at least two units must be taken in 400-level courses.

A thesis is not required, but at least one unit of individual problem work must be included. A comprehensive examination is required of all candidates for the degree. Students who are preparing themselves for high school teaching and who are not yet certified must fulfill state certification requirements.

Doctor of Philosophy in Biology. The School of Life Sciences offers Ph.D. programs in several interdepartmental areas, cell biology and virology, and developmental biology. Entrance requirements, in addition to those listed on page 243 for the M.S. program, include background training in general biology, physics, biochemistry, and calculus, but deficiences in these areas may be remedied during the first year of graduate study. Study programs are designed to suit individual needs in consultation with advisers. Descriptions of the area programs are given below.

Students who have been accepted for one of these programs may select any faculty member in the School of Life Sciences, or an appropriate member of the Biochemistry Division as a major adviser. Additional information may be obtained from the Director of the School of Life Sciences.

CELL BIOLOGY AND VIROLOGY

The cell biology and virology program emphasizes molecular mechanisms and is therefore addressed to students who have acquired or wish to acquire a strong background in chemistry. Areas of research open to students in this program include cytochemistry, biochemistry of subcellular systems, cellular differentiation, intercellular regulation of meiosis and mitosis, circadian rhythms, cellular genetics, and virology.

GENETICS

See page 195.

PLANT PHYSIOLOGY

Plant physiology is an interdepartmental area of specialization coordinated under the biology program. The program is staffed by plant physiologists from the five plant science departments (Agronomy, Botany, Forestry, Horticulture, and Plant Pathology). Thesis research can be conducted in any of these departments. Areas of research include photosynthesis, respiration, membrane transport, nitrogen, herbicide action, water relations, and environmental physiology. In addition to plant physiology, students are required to complete courses in biochemistry and physical chemistry.

Biology

The following courses are administered directly by the School of Life Sciences. These courses, as is the case with departmental courses, are applicable to the study programs within the School.

COURSES FOR GRADUATES

409. History of Biology. The development of biological concepts from the classical Greek period to the present. 1 unit. Prerequisite: Consent of instructor.

423. Electron Microscopy. Same as Chemistry 423. Lectures, discussions, and demonstrations on the physical principles and electron optics of the transmission electron microscope and its modern variants, including lectures and demonstrations of modern high vacuum techniques. Open to qualified graduate students in all departments. ½ unit. Prerequisite: A course in modern physics or physical

chemistry (having calculus as a prerequisite) affording an introduction to wave mechanics, or consent of instructor. HALL.

429. **Electron Microscopy with Laboratory.** Same as Chemistry 429. General lectures on theory and design of electron microscopes without mathematical derivations; discussion and practice on specimen preparation; operation of electron microscopes with separate sections to meet special needs of biologists, geologists, and those interested in electron diffraction. Most theory lectures may be omitted by those enrolled or having credit in Biology or Chemistry 423. Open to qualified graduate students in all departments. 1 unit. Prerequisite: Two semesters of general physics, two semesters of college mathematics, and three semesters of chemistry; or consent of instructor. HALL, HARMER.

430. **Biological Ultrastructure.** Lectures and reports on the fine structure of plant and animal cells and cell products with discussions of possible relationships of ultrastructure to function and of diverse interpretations of chemical-physical information as ultrastructure. 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Consent of instructor. HALL.

490. **Special Topics in Biology.** Individual topics in research and/or reading conducted under the supervision of faculty members in the School of Life Sciences. This course is particularly designed for students enrolled in the biology program who would like to become more familiar with specialized fields of study prior to committing themselves to a specific area for their doctorate degree. 0 to 1 unit.

493. **Advanced Electron Microscopy.** Conferences and practice dealing with specialized laboratory techniques, preparation of specimens, and the analysis and study of varied materials by use of transmission and/or scanning electron microscopes, and by the techniques of electron diffraction. Open to qualified students in all departments. ¼ or ½ unit. Prerequisite: Biology or Chemistry 429; consent of instructor.

499. **Thesis Research.** 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

307. **Immunology.** Introductory course in the fundamentals of immunology with emphasis on biological application; designed to give a basic background for understanding immunological responses with an introduction to techniques applicable to biological research. ¾ unit. Prerequisite: Four semesters of college biology; Chemistry 133 or 234 or consent of instructor.

308. **Experimental Immunobiology.** An introduction to laboratory techniques employed in immunological investigations. Laboratory. ½ unit. Prerequisite: Credit or registration in Biology 307; consent of instructor.

310. **Principles of Population Biology, I.** The sequence Biology 310 and 311 provides an integrated treatment of population concepts in biology. Major topics covered include: ecology, ethology, population genetics, and evolution. ¾ unit. Prerequisite: Biology 210 or consent of instructor; college algebra.

311. **Principles of Population Biology, II.** Continuation of Biology 310. ¾ unit. Prerequisite: Biology 310 or consent of instructor.

351. **Population Biology.** A study of problems associated with the behavior of plant and animal populations based on genetic, evolutionary, and ecological principles. ¾ unit. Prerequisite: Biology 151 and 251, and/or consent of instructor. GHENT.

371. **Quantitative Biology.** Theory and practical application in biology of probability and statistics. Lectures and assigned problems. ¾ unit. Prerequisite: College algebra; consent of instructor.

DEPARTMENTAL STUDY PROGRAMS AND COURSES

Botany

The Department of Botany offers graduate work leading to the Master of Science and Doctor of Philosophy. Candidates for advanced degrees must have had at least twenty hours of undergraduate work in botany, or fifteen hours in botany and five hours in a related subject acceptable to the department. The applicant's grade-point average must be at least 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

The following subjects comprise a partial listing of the areas of specialization available in the department: cytology, cytogenetics, anatomy, morphology, morphogenesis, paleobotany, ecology, plant geography, taxonomy, cytotaxonomy, physiology (including photosynthesis), physiological genetics, mycology, phycology, virology, and ultrastructure.

Courses offered in the departments of Agronomy, Chemistry and Chemical Engineering, Entomology, Geography, Geology, Horticulture, Mathematics, Microbiology, Physics, Physiology and Biophysics, Plant Pathology, and Zoology are available to advanced students and offer a broad foundation for botanical work. Graduate students in botany may elect their minor subjects in one or two of these fields.

Special Facilities. Graduate students may avail themselves of the University herbarium which contains 500,000 specimens of vascular plants, bryophytes, algae, fungi, and fossil plants. As field laboratories, the University maintains two tracts of woodland, Brownfield Woods and Trelease Woods; in addition, certain areas of Robert Allerton Park near Monticello have been designated for research and study. Greenhouses, garden plots, and growth chambers are maintained for experimental work with living plants. Well equipped laboratories are available for each area of specialization within the department. The Maize Genetics Research Laboratory maintains an extensive collection of maize genetic stocks adapted to the North Central states; the College of Agriculture and the Agricultural Experiment Station offer exceptional facilities to graduate students in plant genetics, plant pathology, and in some of the other plant sciences. The Biology Library, with over 70,000 volumes, offers excellent library facilities, with bibliographical aids including the Gray Herbarium Card Index of American Plants, the Index of American Botanical Literature of the Torrey Botanical Club, and the Tilden Index Algarum Universalis.

Departmental Qualifying Examination. A written qualifying examination must be taken by all new graduate students majoring in botany at the beginning of their first semester. This examination is offered in the week prior to the opening of the first or fall semester and is used to determine the level of information in the following areas: (1) ecology, (2) genetics, (3) morphology, (4) physiology, and (5) taxonomy. The results of the examination are used by the departmental qualifying examination committee and the student's adviser to recommend future graduate courses, and no permanent record is made of the results.

Students with deficient preparation in any one of the five areas can remove the deficiency: (1) by passing an examination in the deficient areas or substitute areas after a period of independent reading and study; (2) by registration in a course in the field of deficiency and by passing the course with a grade of B or better; (3) by substitution of courses in botany, approved by the qualifying examination committee and the adviser. A limit of two substitutions is allowed for each student.

Master of Science. During their graduate or advanced undergraduate work, canidates for this degree must have completed courses in the following basic fields of botany: (1) taxonomy (Botany 260 or 366 or equivalent), (2) morphology (Botany 304 or equivalent), (3) ecology or plant geography (Botany 381 or equivalent), (4) genetics (Botany 210 or equivalent), (5) physiology (Botany 330 and 335 or equivalent).

A thesis is not required of candidates for the Master of Science except at the option of the graduate student's major adviser. Graduate students do not receive credit toward the master's degree in Botany 499 unless they write acceptable master's theses. A student may engage in graduate work toward the Doctor of Philosophy without having obtained a master's degree.

Doctor of Philosophy. Candidates for this degree must complete the course requirements listed above before receiving the Doctor of Philosophy. Having satisfied these basic course requirements imposed by the qualifying examination, the candidate for the doctor's degree may elect whatever other graduate courses he desires, subject to the approval of this major adviser and to the general regulations of the Graduate College concerning requirements in his major and minor fields (see pages 46 to 48).

GRADUATE FACULTY

Professors: J. B. Hanson (Head of Department), L. M. Black, H. J. Fuller, G. N. Jones, J. R. Laughnan, E. I. Rabinowitch, M. E. Reichmann, D. P. Rogers, D. M. Steffensen.

Associate Professors: Z. B. Carothers, Govindjee, J. F. Nance, D. J. Paolillo, T. L. Phillips.

Assistant Professors: J. S. Boyer, L. R. Hoffman, R. MacLeod, W. W. Payne.

COURSES FOR GRADUATES

402. **Molecular Genetics.** See Zoology 402. ¾ unit. Prerequisite: Microbiology 330 or equivalent. Atwood, Spiegelman, Woese.

403. **Physiology of Fungi.** Same as Plant Pathology 403. The germination, growth, metabolism, and sporulation of fungi; physiology of the fungi as related to parasitism, antibiotic production, vitamin assay, and industrially important products. The nature of fungicidal activity is discussed. 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Organic chemistry or biochemistry; mycology, plant pathology, or microbiology. Gottlieb.

405. **Microbiological Genetics.** See Microbiology 405. ¾ unit. Prerequisite: Microbiology 330; mathematics through calculus, or consent of instructor. Atwood, Nanney, Spiegelman.

410. **Botany Discussions.** All graduate students in botany, except those with conflicting teaching assignments, are required to register in and attend the general seminar. No credit is given except to those students presenting the results of their Ph.D. thesis research. 0 or ¼ unit. Staff.

411. **Discussions in Genetics and Cytogenetics.** Same as Microbiology and Zoology 411. ¼ unit. Bader, Brown, Drake, Kitzmiller, Laughnan, Nanney, Steffensen.

413. **Discussions in Plant Physiology.** ¼ unit. Staff.

414. **Discussions in Plant Morphology and Taxonomy.** ¼ unit. Staff.

418. **Discussions in Plant Ecology and Plant Geography.** Developments in ecology and plant geography, with emphasis on one special division. ¼ unit; total credit is limited to 1½ units. Prerequisite: Graduate standing in botany, entomology, geography, or zoology. Staff.

419. **Discussions in Photosynthesis and Related Topics.** ¼ unit. Prerequisite: Consent of instructor. Govindjee, Rabinowitch.

421. **Cytogenetics.** Same as Zoology 421. Chromosome theory: the structure, behavior, and physiology of chromosomes in heredity and development. 1 unit. Prerequisite: Biology 210, or Microbiology 330, or consent of instructor. Steffensen.

424. **Mineral Nutrition of Plants.** Same as Agronomy and Horticulture 424. A study of the uptake, transport, and metabolic utilization of mineral nutrients by plants. The scope of the course is to present the essentiality of various anions and cations in the light of metabolic activity and constituency in functional plant compounds. Major emphasis is placed on metabolic activity and function of the elements. 1 unit. Prerequisite: Botany 330 or consent of instructor. HAGEMAN.

427. **Discussions in Mycology.** A seminar course designed for discussion of current research activities in the morphology, taxonomy, and physiology of fungi, especially the nonparasitic forms. ¼ unit. Prerequisite: Consent of instructor. ROGERS.

433. **Advanced Physiology of Growth, Responses, and Reproduction.** 1 unit. Prerequisite: Botany 330 or equivalent. DICKINSON, MCCOLLUM, NANCE, WILSON.

436. **Advanced Plant Physiology: Photosynthesis.** Same as Agronomy 436. A lecture and laboratory course dealing with physiological, biochemical, and biophysical aspects of photosynthesis. 1 unit. Prerequisite: One year each of college biology, chemistry, and physics, or consent of instructor. GOVINDJEE, OGREN.

442. **Environmental Plant Physiology.** A lecture course dealing with the interaction of plants and environment at the level of the whole organism, extending to the cell and the community. Heat and mass transfer, plant and soil potentials, and the effects of light on growth are emphasized. ¾ unit. Prerequisite: Chemistry 133, general physics, general or plant physiology, and consent of instructor. BOYER.

443. **Environmental Plant Physiology Laboratory.** A laboratory course illustrating quantitative techniques for studying the response of whole plants to environment. Experiments are designed to illustrate methods of gas analysis and advanced techniques for measuring energy balance, potentials, and matter flow through plants. ¾ unit. Prerequisite: Chemistry 133, general physics, general or plant physiology, and consent of instructor; credit or registration in Botany 442. BOYER.

450. **Phycology.** Morphology, physiology, genetics, taxonomy, and ecology of algae. 1 unit. Prerequisite: One year of botany or another biological science, or consent of instructor. HOFFMAN.

460. **Advanced Taxonomy of Flowering Plants, I.** Phylogenetic study of flowering plants; relationship of the principal orders and families; problems of nomenclature; identification of specimens. ½ or 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Botany 260 or one year of botany or another biological science, or consent of instructor. JONES.

461. **Advanced Taxonomy of Flowering Plants, II.** The application of cytology, ecology, genetics, and morphological analyses to the study of evolution and the natural relationships of populations as exemplified by species of higher plants. 1 unit. Offered in 1968-1969 and in alternate years. Prerequisite: Botany 260 and Biology 210, or equivalent; consent of instructor. PAYNE.

471. **Advanced Mycology: Special Groups.** The several classes of fungi and their activities are considered in successive semesters. Special groups within these classes may be selected for concentrated study, depending upon the student's interest in mycology. ½ unit. Prerequisite: Botany 372 or consent of instructor. ROGERS.

482. **Ecological Methods.** Field methods used in plant ecology. 1 unit. Offered in 1968-1969 and in alternate years. Prerequisite: One year of botany including Botany 381 or equivalent. BOYER.

485. **Plant Geography of North America.** Vegetation regions and principal subdivisions; environments, plant cover, floras. 1 unit. Offered in 1969-1970 and in

alternate years. Prerequisite: Botany 381 or equivalent; one course in geology is recommended. Bazzaz.

493. **Advanced Studies in Botany.** ½ to 2 units. Not more than one unit may be applied toward the Graduate College master's degree requirement of three units of course work at the 400 level. Work may be taken in the following fields:
(a) **Anatomy.** Carothers, Paolillo.
(b) **Bryology.** Jones.
(c) **Cytogenetics.** Steffensen.
(d) **Cytology.** Steffensen.
(e) **Ecology.** Bazzaz.
(f) **Genetics.** Laughnan.
(g) **Morphogenesis.** Paolillo.
(h) **Morphology.** Carothers, Phillips.
(i) **Mycology.** Rogers.
(j) **Paleobotany.** Phillips.
(k) **Photosynthesis.** Govindjee, Rabinowitch.
(l) **Phycology.** Hoffman.
(m) **Physiology.** Boyer, Hanson, Nance.
(n) **Taxonomy.** Jones, Payne.
(o) **Ultrastructure.** Carothers, Hoffman, Paolillo.
(p) **Virology.** Black, MacLeod, Reichmann.

499. **Thesis Research.** Individual work under supervision of members of the staff in their respective fields. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Individual Topics.** For seniors and first-year graduate students who wish to study individual problems and topics not assigned in other courses. Graduate students may not offer more than one unit in Botany 300 toward a master's degree. ¼ or ½ unit. Prerequisite: Botany 100; ten hours of advanced work in botany or another biological science. Staff.

304. **General Plant Morphology.** A lecture and laboratory course dealing with the structure, reproduction, and evolution of representative algae, fungi, bryophytes, pteridophytes, gymnosperms, and angiosperms. 1 unit. Prerequisite: Botany 100, or Biology 110 and 111, or Division of General Studies 131 and 132, or Biology 151 and 251, or consent of instructor. Rogers.

305. **Comparative Morphology—Embryophytes.** A lecture and laboratory course dealing with the development, structure, reproduction, and evolution of bryophytes, lower vascular plants, and gymnosperms, with an introduction to angiosperms. One or two field trips. 1 unit. Prerequisite: Botany 100 or equivalent. Paolillo, Phillips.

306. **Biology for Teachers.** Same as Zoology 306. A teacher-training and review course for those engaged in or preparing for teaching general biology in high school. This course adjusted to professional semester (practice teaching) for students in teacher-training curriculum. Two four-hour field trips to be given on Saturdays. ½ unit. Prerequisite: Botany 100 and Zoology 104, or a one-year course in general biology; expectation of teaching. Staff.

325. **Paleobotany.** Same as Geology 325. The structure, phylogeny, and geological distribution of representative fossil plants. Two or three field trips. 1 unit. Prerequisite: Botany 100 or Division of General Studies 131 and 132, and Geology 101; or consent of instructor. Phillips.

330. **Plant Physiology.** A general course concerned with plant functions including water relations, mineral nutrition, metabolism, growth, and reproduction. ½

unit. Prerequisite: Chemistry 133 and Botany 100, or Biology 110 and 111, or Division of General Studies 131 and 132, or Biology 151 and 251. Boyer, Govindjee, Nance.

331. Experimental Cytology. Same as Zoology 331. Organization of cells of higher organisms with emphasis on the relationships between structure and function. The laboratory stresses modern cellular techniques. 1 unit. Prerequisite: Biology 151, 210, or 251; consent of instructor. Davenport, Steffensen.

335. Plant Physiology Laboratory. A laboratory course in plant physiology. A supplement to Botany 330; serves the needs of those interested in acquiring familiarity with techniques of plant physiology. ½ unit. Prerequisite: Credit or registration in Botany 330 or equivalent. Boyer, Govindjee, Nance.

340. Histological Technique. Survey of techniques used in the preparation of plant tissues for microscopical examination. 1 unit. Prerequisite: One year of botany or ten hours of zoology; consent of instructor. Black, MacLeod.

341. Field Ecology. Study of plant communities in various sections of North America during spring vacation (trips rotate on a three-to-five-year basis); outdoor cooking and camping; transportation in University cars. ¼ unit; may be repeated for a maximum of ¾ unit. Prerequisite: One of the following—Botany 260, 366, 381, 385; consent of instructor. Bazzaz.

345. Plant Anatomy. Study of the internal structure of vascular plants, with special emphasis on development, function, and evolutionary history. 1 unit. Prerequisite: One year of botany. Carothers.

351. Viruses, I. Same as Microbiology and Zoology 351. The study of viruses emphasizing the bacteriophages; statistical, physical, biological, and chemical properties of viruses; analysis of host-virus interactions and of viral genetics. ¾ unit. Prerequisite: Organic chemistry; biochemistry and calculus recommended. Drake.

352. Viruses, II. Same as Microbiology and Zoology 352. Extension of the principles developed in Botany, Microbiology, or Zoology 351 to the study of special plant, animal, and bacterial virus systems. ¾ unit. Prerequisite: Botany, Microbiology, or Zoology 351 or consent of instructor; biochemistry and calculus recommended. Black, MacLeod, Reichmann.

366. Field Botany. Identification and classification of native and naturalized flowering plants of eastern North America. S; ½ or 1 unit. Prerequisite: One course in botany; consent of instructor. Jones, Payne.

372. General Mycology. Structure, classification, and identification of fungi, including those of economic importance. 1 unit. Prerequisite: One year of botany, entomology, microbiology, or zoology. Rogers.

381. Plant Ecology. Principles of ecology, exemplified by vegetation and environments of Illinois. 1 unit. Prerequisite: Botany 260 or equivalent. Bazzaz, Boyer.

Entomology

The Department of Entomology offers graduate work leading to the Master of Science and Doctor of Philosophy. Admission requires a grade-point average of at least 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

Previous training in entomology is not essential. It is recommended that students who intend to study for advanced degrees in entomology gain a thorough grounding in the fundamentals of physical and biological science, mathematics, and the liberal arts.

Master of Science. A candidate for this degree is required to demonstrate competence in insect bionomics, control, morphology, physiology, and taxonomy. This may be done by completing with a grade of B or better courses in the following series: Entomology 302, The Classification of Insects; 319, Insect Control, or 420, Insect Toxicology; 322, Insect Bionomics; 410, Insect Morphology; and 422, Insect Physiology, by passing examinations in these subjects; or by a combination of these methods. Proficiency examinations are given by the department in the week before each semester begins. Electives, including thesis research, make up the balance of the eight-unit requirement. If research credit is presented, a thesis is required.

Doctor of Philosophy. A candidate for this degree must satisfy the requirements for the Master of Science in Entomology. The rest of the candidate's program is determined in consultation with his adviser and representatives of the department or departments in which the minor courses are taken. All minor credit must be earned outside the Department of Entomology. The minor or minors are generally selected from the biological and physical sciences.

The chief areas of specialization in the department are behavior, bionomics, economic entomology, medical entomology, morphology, physiology, taxonomy, and toxicology. The facilities of both the department and the State Natural History Survey are available for advanced study in these areas.

GRADUATE FACULTY

Professors: C. W. Kearns (Head of Department), G. Fraenkel, S. Friedman, W. R. Horsfall, W. H. Luckman, H. H. Ross, R. B. Selander, J. G. Sternburg.

Associate Professors: A. W. Ghent, E. R. Jaycox, J. R. Larsen, G. P. Waldbauer.

Assistant Professor: Judith H. Willis.

COURSES FOR GRADUATES

410. **Insect Morphology.** A comprehensive study of the internal and external structure of insects from the comparative viewpoint. 1 unit. Prerequisite: Biology 111; consent of instructor. Larsen, Sternburg.

413. **Medical and Veterinary Entomology.** Training in recognition, classification, methods of injury, habits, and control or destruction of insects, mites, and ticks which are predators, parasites, or disseminators of disease among men and domestic animals. 1 unit. Prerequisite: Entomology 103 or 302; or Zoology 320. Horsfall.

420. **Chemistry and Toxicology of Insecticides.** Designed to provide the fundamental information available concerning the mode of action, the relationship of chemical structure to toxicity, and the physiological explanation of the chemical poisoning of insects. 1 unit—Prerequisite: One year of biology, or equivalent in animal sciences; a course in organic chemistry. Kearns, Sternburg.

422. **Insect Physiology.** A study of the principal physiological and biochemical functions of insects, exclusive of sensory functions. 1 unit. Prerequisite: Entomology 302, 410; a course in organic chemistry. Friedman, Larsen.

423. **Insect Behavior.** An analysis of the physiological basis of insect behavior, including a thorough study of the various sensory systems. 1 unit. Prerequisite: Entomology 301 or equivalent. Waldbauer.

424. **Advanced Insect Physiology.** A comprehensive study of the physiological and biochemical interactions between the insect and its environment including: sensory mechanisms, attractants and repellants, nutritional specialization, intermediary metabolism, energy production and utilization, metabolic activity

accompanying functional changes, process controls. 1 unit. Prerequisite: Entomology 422; Chemistry 350. FRIEDMAN, LARSEN.

426. **Seminar in Entomology.** Discussions, reviews, and appraisals of special topics in the field of entomology. ¼ to 1 unit. Prerequisite: Consent of instructor. FRAENKEL, FRIEDMAN, HORSFALL, KEARNS, LARSEN, ROSS, SELANDER, STERNBURG, WALDBAUER, WILLIS.

499. **Thesis Research.** Work may be taken in the following subjects: morphology and embryology of insects, applied entomology, systematic entomology, biology and ecology of insects, insect toxicology, and insect physiology. 0 to 4 units. FRAENKEL, FRIEDMAN, GHENT, HORSFALL, JAYCOX, KEARNS, LARSEN, LUCKMAN, ROSS, SELANDER, STERNBURG, WALDBAUER, WILLIS.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Introduction to Advanced Entomology, I.** Devoted to integrated studies of the principal morphological and physiological characteristics of insects, and is to be followed by similar systematic studies in Entomology 302. 1 unit. Prerequisite: Biology 110 and 111, and Chemistry 101, or consent of instructor. FRIEDMAN, SELANDER, STERNBURG.

302. **Introduction to Advanced Entomology, II.** Presents a comprehensive survey of the systematics and phylogeny of the orders and principal families of insects, together with practical experience in identification of these taxa. 1 unit. Prerequisite: Consent of instructor. SELANDER.

306. **Special Problems.** For students ready to take up some special investigation as the beginning of a thesis problem for an advanced degree. ¼ to 1 unit. Prerequisite: Consent of instructor. STAFF.

312. **Entomology for Teachers.** Recognition of the chief orders of insects in their immature and adult stages, how they develop, life cycles, food, habitats, adaptations for feeding, oviposition, movement, protection, defense, making sound and other functions, interrelation with other organisms, environment, and social life. A collection of insects is identified, mounted, and labeled. Field trips, laboratory, and discussions. S; ½ unit. Prerequisite: One year of biology, botany, zoology, or equivalent.

317. **Classification of Insects.** Advanced study of the systematics and phylogeny of selected insect groups, with a presentation of the principles and methods of systematic entomology. 1 unit. Prerequisite: Entomology 302. SELANDER.

319. **Fundamentals of Insect Control.** The course emphasizes the principles that underlie effective control practices, rather than the details of methods used against specific pests. Both environmental and chemical factors involved in insect control are considered from their basic aspects. 1 unit. Prerequisite: Biology 110, 111; Chemistry 101 or equivalent. HORSFALL, KEARNS.

322. **Insect Bionomics.** This phase of the biology of insects deals with life history and conditions of environment that favor abundance of insects representative of various habitats. 1 unit. Prerequisite: Entomology 103 or 302, or Zoology 320. HORSFALL.

361. **Individual and Group Behavior of Honey Bees.** See Horticulture 361. ½ unit. Prerequisite: One semester of entomology or zoology. JAYCOX.

Microbiology

The Department of Microbiology offers graduate work leading to the Master of Science and Doctor of Philosophy. Students electing microbiology as a major for an

advanced degree must have had, in addition to formal training in general bacteriology or microbiology, chemistry through quantitative analysis and organic chemistry, and fifteen hours of physical or biological sciences. Mathematics through calculus is strongly recommended.

Students who have fulfilled these requirements may apply for admission if they have a grade-point average of at least 4.0.

Candidates for the Master of Science must pass a general comprehensive examination.

MOLECULAR BIOLOGY (Biophysical Chemistry)

The Department of Microbiology in collaboration with the Department of Chemistry and Chemical Engineering offers an area of specialization in biophysical chemistry. The program is flexible and provides the doctoral candidate with basic training in physical biochemistry and biology. Students electing this area should possess a solid background in physics and mathematics. Details of the curriculum are decided individually on the basis of the past experience and interests of the student. It is expected, however, that he will fulfill minor requirements in physical chemistry or biochemistry.

The major research areas are: (1) molecular basis of gene function; (2) structure and activities of proteins and nucleic acids; (3) intracellular organization and distribution of nucleoprotein components; (4) biosynthetic mechanisms of macromolecular replication; (5) immunochemistry.

GRADUATE FACULTY

Professors: L. L. Campbell (Head of Department), K. C. Atwood, F. M. Clark, R. D. DeMoss, R. E. Kallio, S. Spiegelman, R. S. Wolfe, M. J. Wolin.

Associate Professors: J. W. Drake, J. T. Wachsman, C. R. Woese.

Assistant Professors: S. Kaplan, P. S. Sypherd.

COURSES FOR GRADUATES

402. **Molecular Genetics.** Same as Botany and Zoology 402. The nature of the gene, its mode of action, the mechanism of autosynthesis, the organization of the genetic material, and the regulation of gene action. ¾ unit. Prerequisite: Microbiology 330 or equivalent. Atwood, Spiegelman, Woese.

405. **Microbiological Genetics.** Same as Botany and Zoology 405. Breeding systems and recombinational analysis in microorganisms, with particular emphasis on protozoa and fungi. ¾ unit. Prerequisite: Microbiology 330; mathematics through calculus, or consent of instructor. Spiegelman.

409. **Cultivation and Properties of Microorganisms.** Nutritional and metabolic properties of the major groups of microorganisms; a comparative study of the ecology, selective isolation, and cultivation of bacteria. Laboratory. 1 unit. Prerequisite: Chemistry 355 or equivalent; credit or registration in Microbiology 309; consent of instructor. Wolfe, Wolin.

411. **Discussion in Genetics and Cytogenetics.** Same as Botany and Zoology 411. ¼ unit. Drake, Kitzmiller, Laughnan, Nanney, Steffensen.

412. **Advances in Microbiology.** Discussions of current research in several areas of microbiology. Discussions cover the following areas: (a) general microbiology, (b) microbial physiology and metabolism, (c) immunochemistry, (d) molecular genetics. ¼ unit. May be repeated for a maximum of one unit. Prerequisite: Consent of instructor. Staff.

420. **Chemistry of Microbic Processes.** The properties of microorganisms with emphasis on the metabolic pathways and chemical processes involved in the release of energy in the dissimulation of substrates by fermentation and respiration, and in the synthesis of cellular constituents. The metabolic types represented by microorganisms including the heterotrophic, autotrophic, and photosynthetic patterns are included. ¾ unit. Prerequisite: Microbiology 309 or 330 and Chemistry 234 and 350, or equivalent; consent of instructor. DeMoss.

451. **Experimental Virology and Microbial Genetics.** Experiments on the biology, replication, and genetics of bacteriophages and bacteria, with emphasis on experimental design by the students. 1 unit. Prerequisite: Microbiology 351; consent of instructor. Drake.

490. **Individual Problems.** ½ to 2 units. Prerequisite: Consent of instructor. Staff.

495. **Seminar.** Required of all graduate students whose major is microbiology. 0 or ¼ unit. Prerequisite: Ten hours of microbiology; consent of instructor. Staff.

499. **Thesis Research.** 0 to 4 units. Atwood, Campbell, Clark, DeMoss, Drake, Gunsalus, Kallio, Kaplan, Spiegelman, Sypherd, Wachsman, Woese, Wolfe, Wolin.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

309. **Comparative Microbial Chemistry.** Emphasis is placed on comparative biochemical activity and other chemical characteristics as a basis for the discussion of the features of major groups of microorganisms. Comparison of the energy metabolism of the microbial groups is stressed. Lecture. ½ unit. Prerequisite: Chemistry 350 or equivalent. Wolfe, Wolin.

311. **Food and Industrial Microbiology.** The relationship of microorganisms to food manufacture and preservation and to industrial fermentation and processing and to sanitation. Lecture. ¾ unit. Prerequisite: Microbiology 101 or 201 or 309, or equivalent, and credit or registration in organic chemistry; or consent of instructor. Clark.

312. **Techniques of Applied Microbiology.** A consideration, through experimentation, of the properties of the bacteria, yeasts, molds, and actinomycetes which are important to industrial processes. The methods of control of microbial processes in industry and sanitation are explored. Laboratory. ½ unit. Prerequisite: Credit or registration in Microbiology 311. Clark.

326. **Pathogenic Bacteriology.** A study of the parasitism and pathogenic microorganisms: classification, morphology, cultural requirements and reactions, toxins, diagnostic tests, methods of differentiation and recognition, and the diseases bacteria cause. Lectures and laboratory. 1 unit. Prerequisite: Microbiology 101 or 201; organic chemistry.

327. **Immunochemistry.** A survey of the field of immunology with emphasis on its chemical aspects. Lectures and laboratory. 1 unit. Prerequisite: Credit or registration in biochemistry or consent of instructor. Voss.

330. **Metabolic Regulation and Genetics of Microorganisms.** Modern contributions to the science of microbiology, including considerations of the micro- and macromolecular anatomy of the bacterial cell, the physiological and genetic behavior of microorganisms, and the role of bacterial viruses as agents involved in the transfer of genetic information. Lecture. ¾ unit. Prerequisite: Microbiology 101 or 201, or equivalent; credit or registration in biochemistry or consent of instructor; calculus strongly recommended. Sypherd, Woese.

351. **Viruses, I.** Same as Botany and Zoology 351. The study of viruses emphasizing the bacteriophages; statistical, physical, biological, and chemical properties of

viruses; analysis of host-virus interactions and of viral genetics. ¾ unit. Prerequisite: Organic chemistry; biochemistry and calculus recommended. DRAKE.

352. **Viruses, II.** Same as Botany and Zoology 352. Extension of the principles developed in Microbiology, Botany, and Zoology 351 to the study of special plant, animal, and bacterial virus systems. ¾ unit. Prerequisite: Botany, Microbiology, and Zoology 351, or consent of instructor; biochemistry and calculus recommended. BLACK, MACLEOD, REICHMANN.

Physiology and Biophysics

The Master of Science and Doctor of Philosophy are granted in both physiology and biophysics.

Physiology

Admission to graduate study in physiology requires a grade-point average of 4.0. Applications of students with grade-point averages below 4.0 but above 3.5 are considered on an individual basis. Applicants should submit three letters of recommendation, a letter regarding intentions and qualifications, and, if possible, scores on the Graduate Record Examination. There is no departmental requirement of specific undergraduate major or minor fields, but the student whose background is deficient in chemistry, mathematics (including calculus), physics, or biological sciences (including morphology and genetics) must rectify these deficiencies early in his graduate career. Students who have not had a laboratory course in physiology should take Physiology 301 or 302 before they enter the graduate courses in advanced physiology.

Master of Science. To obtain the Master of Science, the student must offer at least eight units in physiology and related subjects. Ordinarily, the program includes Physiology 401, 402, 403, and 404, two units from related departments, and two units of Physiology 491. A research paper based on Physiology 491 must be submitted. Candidates for the Master of Science must pass a general oral examination.

Doctor of Philosophy. Admission to candidacy is based on a qualifying examination after completion of eight units or the Master of Science.

The department requires that the candidate pass a written comprehensive examination covering important areas of physiology before he is permitted to take his oral preliminary examination.

Each candidate must take, either as an undergraduate or as a graduate student, the following courses or their equivalents: Physiology 401, 402, 403, and 404 (combined mammalian, cellular, and comparative physiology); Chemistry 340 or 342 and 344; Chemistry 350 and 355; a course in statistics at the graduate level; and a course in the history and/or the philosophy of science. At some time during the doctoral program, the candidate will be expected to teach for two semesters at half time (or the equivalent).

In addition to satisfying the above requirements for all students, each candidate specializes in one of the following areas: mammalian physiology, comparative physiology, cellular physiology, endocrinology, neurophysiology, human anatomy and human physiology, bioclimatology and environmental physiology, radiobiology. An intradepartmental minor may be offered in most of these areas of specialization, chosen from sequences other than Physiology 401, 402, 403, and 404.

Minor. Graduate students in other departments are assigned by the physiology graduate student counselor to a departmental minor adviser according to their interests. Requirements are as follows: sole minor, four units including two from the 401-404 sequence; split minor, two units of which one is at the 400 level. A sequence of courses within one area of physiology is desirable for a minor.

Biophysics

The objective of the program in biophysics is to give the student sufficient training in physics, chemistry, and biology to enable him to apply the conceptual, instrumental, and mathematical approaches of the physical scientist to the solution of biological problems. The graduate curriculum is administered by a committee representing both the physical and the biological sciences. The curriculum is designed primarily for students entering with a master's degree in a physical science but students with less than a master's degree in physical sciences or biology may be eligible.

Admission requirements for the latter are one year of college biology, one year of college physics, quantitative analysis (five hours), organic chemistry (five hours), and calculus (six hours). However, any deficiencies can be corrected while in training. Applicants must have a grade-point average of at least 4.0.

Master of Science. To obtain the Master of Science, the student must offer at least eight units in biophysics and related subjects. The required courses are Biophysics 401, 402, and two units of additional biophysics courses, a thesis, or special field examination.

For students whose major training has been in the physical sciences, the balance of courses should be selected from the biological science courses; students from the biological sciences select courses from the physical science courses. Candidates for the Master of Science must pass a general examination.

Doctor of Philosophy. A flexible approach is made to curriculum requirements. Students are required, after approximately eight units of graduate study, to pass a qualifying examination, and after sixteen units, to pass a preliminary examination. At some time during the doctoral program, the candidates will be expected to teach for two semesters at half time (or the equivalent). An acceptable course program is given below:

(1) Mathematics, physics, and chemistry: Mathematics 343 or 345; Physics 321, 341, 342, and 381; Chemistry 342, 343, 344, and 345 (a one-year sequence including lectures and laboratory), and Chemistry 350 and 355. Certain of the required physics courses can be waived, upon approval of the committee, in cases where the student has had comparable training in advanced courses in physical chemistry. A knowledge of colloidal and macromolecular phenomena equivalent to one semester of work comparable to Chemistry 346 is necessary for work in biophysics.

(2) Biology: Three units of graduate course work in one of the major areas of biology, determined by the research interests of the student. At least one course in genetics should be included as part of the three-unit requirement in biology.

(3) Biophysics: Biophysics 401 or equivalent; Biophysics 402 and two additional courses in biophysics (other than research).

(4) Minor areas: Students entering from the biological sciences may declare a minor in physics or chemistry, or a minor in both, utilizing required courses in these fields, while students entering from the physical sciences may declare a sole minor in a selected field of biology. Other minors are possible but must meet the approval of the committee.

Minor. Subject to the approval of the committee, candidates for the Doctor of Philosophy in other fields may take a minor in biophysics.

GRADUATE FACULTY

Professors: C. L. Prosser (Head of Department), B. C. Abbott, H. W. Ades, J. D. Anderson, W. R. Ashby, H. S. Ducoff, F. Dunn, J. Gorski, R. E. Johnson, A. V. Nalbandov, E. I. Rabinowitch, F. R. Steggerda, A. B. Taylor, H. I. Teigler, G. J. Thomas, H. M. Von Foerster.

Associate Professors: D. E Buetow, Govindjee, J. H. Heath, B. A. Hertig, J. R. Larsen, S. G. Stolpe, J. S. Willis.

Assistant Professors: E. S. Kirk, C. Sybesma.

Physiology

COURSES FOR GRADUATES

401. **Physiology of Systems and Organs.** Analysis of organization and function of vertebrate systems, combining the viewpoints of traditional cellular, comparative, mammalian, and human physiology; nervous, circulatory, digestive, and excretory systems; gross metabolism. 1 unit. Prerequisite: One year of college-level physics; chemistry through organic; an upper division course in physiology; physical chemistry and biochemistry recommended; knowledge of calculus presumed. Staff.

402. **Comparative and Adaptational Physiology.** Analysis of mechanisms of adaptation to the environment and to environmental stress, combining the viewpoints of traditional cellular, mammalian, and human physiology, with particular emphasis on the comparative approach. Homeostatic theory, nutrition, osmotic and ionic regulation and cell membranes, respiration and metabolism, temperature relations, bioelectrics, contractile systems. 1 unit. Prerequisite: One year of college-level physics; chemistry through organic; an upper division course in physiology; physical chemistry and biochemistry recommended; knowledge of calculus presumed. Staff.

403. **Cellular and Molecular Physiology.** Physicochemical analysis of cellular function and consideration of the implications of the properties of cells for the physiology of multicellular animals. Cell and its organization, cell and the organism, protein structure and specificity, regulation of cell metabolism, cellular basis of hormone action, photobiology. 1 unit. Prerequisite: One year of college-level physics; chemistry including physical and biochemistry; an upper division course in physiology; knowledge of calculus presumed. Staff.

404. **Physiological Measurements.** Lectures and laboratories concerned with an introduction at a graduate level to current research techniques in the physiological sciences. The laboratories are problem-oriented, and students select four to six special topics, at least one of which must be in each of the following major areas of physiology: (1) nervous system and muscles; (2) mammalian and human; (3) adaptation and radiation biology, and comparative physiology; (4) molecular, cellular, and endocrinological physiology. Within each area there are problems which fall into one or more of the following experimental categories: electrical-mechanical, chemical, and surgical. Selection of problems is done in conjunction with the course secretary so that the student obtains familiarity with techniques in each of these experimental categories and can devote some time to material of consequence relating to his own research interests. Emphasis is placed on the ability to work independently, and students give oral and written reports of their experimentation. 1¼ units. Prerequisite: Chemistry 355 or equivalent, or consent of instructor. Staff.

410. **Mammalian Physiology Seminar.** Current trends in mammalian physiology. ½ unit. Prerequisite: Physiology 401 and 402, or equivalent; consent of instructor. Kirk, Steggerda.

412. **Advanced Endocrinology.** Same as Animal Science, Dairy Science, and Zoology 412. Seminar, lectures, student reports, and discussions of recent advances in endocrinology. The course may be repeated for credit not to exceed a total of two units. ½ unit. Prerequisite: Physiology 312; consent of instructor. Gorski, Nalbandov.

413. **Experimental Mammalian Physiology, I.** The physiological applications of experimental mammalian surgery. 1 unit. Prerequisite: Physiology 401 and 402, or equivalent; consent of instructor. STEGGERDA.

414. **Experimental Mammalian Physiology, II.** The physiological applications of experimental pharmacodynamics. 1 unit. Prerequisite: Physiology 401 and 402, or equivalent; consent of instructor. STEGGERDA.

416. **Structure and Function of the Nervous System.** The understanding of nervous function through the experimental approach. 1 unit. Prerequisite: Two semesters of physiology courses beyond the elementary level; two semesters of general physics; consent of instructor. ADES.

421. **Gross Human Anatomy.** A general survey of the structures of the human body with emphasis on the relations between form and function. 1 unit. Prerequisite: One semester of embryology; consent of instructor. STOLPE.

425. **Quantitative Neuroanatomy Lecture.** Same as Electrical Engineering 425. A detailed consideration of (1) quantitative methods of studying structure in the central nervous system, (2) analysis of quantitative data concerning cell and fiber populations and related characteristics in both normal and modified brains, and (3) derivation of neuronal circuitry. 1 unit. Prerequisite: Physiology 416 or equivalent; consent of instructor. FRY.

426. **Quantitative Neuroanatomy Laboratory.** Same as Electrical Engineering 426. Practice in the use of quantitative methods for precisely determining nerve cell populations and other components of the central nervous system and in measuring properties of subcellualr components of anatomic significance. 1 unit. Prerequisite: Physiology 416 or equivalent; consent of instructor. FRY.

431. **Experimental Radiobiology.** Laboratory exercises in irradiation procedures and in the examination of biological responses to ionizing radiations. 1 unit. Prerequisite: Physiology 331 or equivalent; consent of instructor. DUCOFF.

441. **Advanced Comparative Physiology.** Same as Zoology 441. Seminar, lectures, student reports, discussions. ½ unit. Prerequisite: Consent of instructor. STAFF.

442. **Advanced Comparative Physiology Laboratory.** Same as Zoology 442. Laboratory experiments presenting comparative principles in osmotic and ionic regulation, respiration and metabolism, temperature regulation of animals, physiology of circulatory systems, of muscle, of sense organs and nervous systems. 1 unit. Prerequisite: Physiology 402, 403, and 404; credit or registration in Physiology 441. PROSSER.

451. **Advanced Cellular Physiology.** Same as Zoology 451. Seminar, lectures, student reports, discussions. ½ unit. Prerequisite: Consent of instructor. STAFF.

461. **Fundamentals of Bioclimatology.** Same as Geography 461. The effects of physical factors (such as barometric pressure, temperature, humidity, radiation, and air movement) on physiological processes in mammals; and the application of meteorological, climatological, and geographical techniques in physiological studies. ¾ unit. Prerequisite: Consent of instructor. ARMSTRONG, SARGENT.

462. **Experimental Bioclimatology.** Same as Geography 462. Laboratory work and demonstrations on methods of measuring meteorological factors, of clinical thermometry, and partitional calorimetry; laboratory work on physiological adjustments of man to heat, cold, and high altitude. ½ unit. Prerequisite: Physiology 301, or 401 and 402; credit or registration in Physiology 461. ARMSTRONG, SARGENT.

464. **Advanced Human Bioclimatology.** Same as Geography 464. Topics in human bioclimatology and medical geography, such as climatic determinism, meteorotropism, the weather elements as stresses, and acclimatization. ½ unit. Prerequisite: Physiology 461. ARMSTRONG, SARGENT.

470. **Human Pathologic Physiology.** Disturbances of function in tissues and organs and their relationship to the pathogenesis of human disease. ¾ unit. Prerequisite: Two semesters of advanced physiology; one semester of biochemistry; consent of instructor. JOHNSON, TEIGLER.

472. **Human Physiology Seminar.** Topics of current emphasis in human physiology. ½ unit. Prerequisite: Two semesters of advanced physiology; one semester of biochemistry; consent of instructor. JOHNSON, TEIGLER.

473. **Ergonomics Seminar.** Same as Industrial Engineering 473. Topics in ergonomics are explored in depth, such as effects of vibration on human performance and biomechanics of the hand. ½ unit. Prerequisite: Industrial Engineering 306 or consent of instructor.

491. **Individual Topics.** For graduate students who wish to study individual problems or topics not assigned in other courses. ½ to 2 units. Prerequisite: Approval of department. STAFF.

499. **Thesis Research.** 0 to 4 units. Research may be conducted in the following areas, with the consent of the instructor:
   (a) **Cellular Physiology and Radiobiology.** ABBOTT, ANDERSON, BUETOW, DUCOFF, GORSKI, PROSSER, TAYLOR, WILLIS.
   (b) **Comparative Physiology.** ABBOTT, ANDERSON, HEATH, LARSEN, PROSSER, WILLIS.
   (c) **Mammalian Physiology.** KIRK, NALBANDOV, STEGGERDA.
   (d) **Human Anatomy and Human Physiology.** JOHNSON, STOLPE.
   (e) **Endocrinology.** FOSTER, GORSKI, NALBANDOV, STOLPE.
   (f) **Neurophysiology.** ADES.
   (g) **Bioclimatology.**
   (h) **Environmental and Stress Physiology.** HERTIG, JOHNSON.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **General Physiology.** Same as Zoology 301. A consideration from the standpoint of experimental biology of functions that are common to most living organisms. 1 unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent; one year each of college-level mathematics and physics; chemistry through organic. ANDERSON, STAFF.

302. **Experimental Animal Physiology.** Same as Zoology 302. Organ physiology of animals with emphasis on homeostasis and physiological interactions of animals with their environment. 1 unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent; one year each of college-level mathematics and physics; chemistry through organic. ANDERSON, STAFF.

305. **Principles of Ergonomics.** Same as Industrial Engineering 305. Concepts and design criteria to achieve optimum mutual adjustment of man and his work. Static and dynamic forces on the human frame; response to environmental stress (heat, vibration, noise); vigilance and fatigue; and man-machine systems are considered. 1 unit. Prerequisite: Consent of instructor.

306. **Quantitative Methods in Ergonomics.** Same as Industrial Engineering 306. Laboratory problems and discussion on measurements of the physical and mental capacities and limitations of human beings in relationship to the stresses and demands of working environment. Students become familiar with techniques and tools such as assessment of human energy expenditures on an industrial job, use of seating research chair; high speed and time lapse photography. Student teams select about six problems from a list of topics, or they may develop problems of special interest to the team. 1 unit. Prerequisite: Physiology or Industrial Engineering 305.

312. **Endocrinology.** Same as Zoology 312. The glands of internal secretion with special reference to the vertebrates. ¾ unit. Prerequisite: Physiology or Zoology 301, or a course in biochemistry; consent of instructor. GORSKI.

313. **Experimental Endocrinology.** Same as Zoology 313. Laboratory techniques and project in endocrinology. ½ unit. Prerequisite: Credit or registration in Physiology or Zoology 312; consent of instructor. GORSKI.

331. **General Radiobiology.** Responses of multicellular organisms, cells, and macromolecules to ionizing radiations. Lectures, student reports, and discussions. 1 unit. Prerequisite: One year each of mathematics, physics, chemistry, and biology. DUCOFF.

369. **Introduction to Human Ecology.** Same as Anthropology, Geography, Health Education, Sociology, Veterinary Medical Science, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations, and physiological, psychological, and sociological adjustments to environment, regulation of populations, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology; one year of anthropology, geography, geology, or sociology. SHIMKIN, STAFF.

374. **Problems in Human Ecology.** Same as Anthropology, Geography, Health Education, Psychology, Sociology, and Veterinary Medical Science 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multi-disciplinary studies of selected current problems. 1 unit. Prerequisite: Anthropology, Geography, Health Education, Physiology, Sociology, or Zoology 369. LEVINE, STAFF.

Biophysics

COURSES FOR GRADUATES

401. **Advanced Biophysics, I.** Topics from electrobiology, muscle biophysics, and physical properties of biological media. 1 unit. Prerequisite: One year of physics beyond introductory physics or equivalent; calculus; physical chemistry; or consent of instructor.

402. **Advanced Biophysics, II.** Photobiology, including photosynthesis, bioluminescence, and visual reception. 1 unit. Prerequisite: One year of physics beyond introductory physics or equivalent; calculus; physical chemistry.

403. **Biophysical Techniques.** This course is designed to acquaint the student with physical methods useful in the solution of biological problems. Topics covered are bioelectric measurements, including basic electronics; optical methods, including microsocopy, spectrophotometry, and measurement of action spectra; use of high energy radiations; tracer techniques; acoustical techniques. ½ or 1 unit. Prerequisite: Credit or registration in Biophysics 402, or consent of instructor. DUNN, MATSUMOTO.

410. **Special Topics in Biophysics.** An advanced course on some topic of interest in biophysics, such as electrobiology, radiation biology, photobiology, bioacoustics, or the physics of muscular contraction. ½ to 1 unit. Prerequisite: Biophysics 401 or equivalent; Biophysics 402 and 403.

411. **Seminar.** Survey of the literature in one area of biophysics, with special emphasis on student reports. ½ unit. Prerequisite: Enrollment in the biophysics program or consent of instructor.

436. **Problems of Cybernetics.** Same as Communications 436 and Electrical Engineering 474. The study of brain-like processes in complex dynamic systems with

emphasis on unsolved problems, current developments, and opportunities for research. 1 unit. Prerequisite: Consent of instructor. ASHBY.

463. **Radioisotopes in Biological Research: Principles and Practice.** See Veterinary Medical Science 463. ¾ unit. Prerequisite: Quantitative chemistry; one year each of mathematics, physics, biology, and/or consent of instructor.

491. **Individual Topics.** For graduate students who wish to study individual problems or topics not assigned in other courses. ½ to 2 units. Prerequisite: Consent of instructor. STAFF.

499. **Thesis Research.** Research may be conducted in one of the areas listed below, subject to approval of the staff member concerned and the department in which the research is to be done. 0 to 4 units.
(a) **Bioacoustics.** DUNN.
(b) **Cellular Physiology.** BUETOW.
(c) **Electrobiology.** ABBOTT, PROSSER.
(d) **Photosynthesis.** GOVINDJEE, RABINOWITCH, SYBESMA.
(e) **Microbiology.** SPIEGELMAN, WOESE.
(f) **Physics of Muscular Contraction.** ABBOTT.
(g) **Radiobiology.** DUCOFF.
(h) **Information Theory and Cybernetics.** ASHBY, VON FOERSTER.
(i) **Ion Transport and Permeability.** ABBOTT.
(j) **Mechanical Properties of Tissues.** GILMAN.
(k) **Vascular Dynamics.** KIRK.
(l) **Central Nervous System.** ADES.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Introduction to Biophysics.** A review of the field of biophysics designed to introduce the student to the types of biological problems currently under investigation in biophysical laboratories. ¾ unit. Prerequisite: Eight hours of physics or enrollment in the graduate biophysics program.

312. **Introduction to Radiobiology.** Nature and mechanisms of the biological consequences of low dose and chronic irradiation. Intended primarily for students in engineering and physical sciences. ½ unit. Prerequisite: Mathematics 142 or 143; eight hours of physics; consent of instructor.

Zoology

The Department of Zoology offers work leading to the degrees of Master of Science and Doctor of Philosophy. Five areas of specialization are available: vertebrate zoology; invertebrate zoology; embryology and basic knowledge of cells and tissues; ecology, ethology, natural history, and taxonomy; and genetics, phylogeny, and evolution.

The grade-point average for admission is 4.0. Applicants with grade-point averages below 4.0 but above 3.75 are considered on an individual basis. Applicants should have completed twenty-five hours of biology, three semesters of college chemistry including organic, two semesters of college mathematics including analytic geometry, and two semesters of physics, or equivalent. Knowledge of a foreign language is necessary and the following are recommended: French, German, Russian; Latin and Greek also are helpful.

The Master of Science requires eight units of graduate credit, including at least one course in each of the following six areas in biology: (1) general invertebrate zoology, (2) vertebrate morphology, (3) embryology or developmental biology, (4) ecology, ethology, or population biology, (5) advanced physiology, and (6) genetics. Students are required to complete a thesis (Zoology 499), or a research report (Zoology 490), and, at the end of the program, complete a successful oral examination.

Admission to advanced standing requires the master's degree or the equivalent, a 4.3 grade-point average in non-thesis biology courses, and presupposes that the minimum science requirements specified for the master's degree have been met. Additional science requirements for the doctorate include at least one course each in statistics, calculus, and biochemistry. Quantitative chemistry and other courses may be recommended by the adviser or doctoral committee. Further details relating to work in specialized areas in zoology and departmental requirements may be obtained by writing to the head of the department, 287 Morrill Hall.

Graduate students in other departments who choose zoology as a minor must have had at least one year of undergraduate work in zoology.

GRADUATE FACULTY

Professors: P. H. Silverman (Head of Department), R. S. Bader, G. W. Bennett, B. V. Hall, J. Hirsch, D. F. Hoffmeister, L. Ingle, S. C. Kendeigh, J. B. Kitzmiller, F. J. Kruidenier, N. D. Levine, A. V. Nalbandov, D. L. Nanney, C. L. Prosser, G. C. Sanderson, H. M. Smith, P. W. Smith, R. L. Watterson.

Associate Professors: E. M. Banks, A. W. Ghent, J. E. Heath, M. R. Lee, M. R. Matteson, H. H. Shoemaker.

Assistant Professors: Nelda E. Alger, E. H. Brown, R. Davenport, P. S. Dawson, D. C. Eades, T. H. Frazzetta, C. E. King, M. Salmon, E. B. Small, D. C. Sweeney, Mary F. Willson.

COURSES FOR GRADUATES

402. Molecular Genetics. See Microbiology 402. ¾ unit. Prerequisite: Microbiology 330 or equivalent. Atwood, Spiegelman, Woese.

405. Microbiological Genetics. See Microbiology 405. ¾ unit. Prerequisite: Microbiology 330; mathematics through calculus, or consent of instructor. Atwood, Nanney, Spiegelman.

406. Physiology of Reproduction. Same as Animal Science 406. Comparative physiology of reproduction and endocrinology of domestic and laboratory animals; fertility and sterility. Lectures and laboratory. 1 unit. Nalbandov.

407. Evolutionary Theory. Genetic, systematic, ecological, and zoogeographical concepts as related to the process of evolution. 1 unit. Prerequisite: One course in genetics; consent of instructor. Bader.

408. Laboratory Methods in Physiology of Reproduction. Same as Animal Science 408. ½ to 1 unit. Prerequisite: Consent of instructor. Nalbandov.

411. Discussions in Genetics and Cytogenetics. Same as Botany and Microbiology 411. ¼ unit. Brown, Dawson, Drake, Kitzmiller, Laughnan, Nanney, Steffensen.

412. Advanced Endocrinology. See Physiology 412. Course may be repeated for credit not to exceed a total of two units. ½ unit. Prerequisite: Physiology 312; consent of instructor. Gorski, Nalbandov.

418. Advanced Protozoology. Advanced consideration of selected topics, with emphasis on laboratory practice in modern methods and techniques of studying both free-living and parasitic protozoa: collecting, culturing, and staining of representative forms. 1 unit. Offered in 1968-1969 and in alternate years. Prerequisite: Zoology 318 or equivalent. Small.

419. Topics in Experimental Protozoology. Consideration of the advantageous employment of protozoa in modern researches concerned with basic biological problems; selected experimental topics covered by lectures, demonstrations, discussions,

reports, and readings. ½ or 1 unit Offered in 1969-1970 and in alternate years. Prerequisite: Consent of instructor. SMALL.

420. **Experimental Invertebrate Zoology.** Study of current research problems and practice in the experimental methods used in the area of invertebrate zoology. 1 unit. Prerequisite: Zoology 320 or equivalent; consent of instructor. SWEENEY.

421. **Cytogenetics.** See Botany 421. 1 unit. Prerequisite: Biology 210, or Microbiology 330, or consent of instructor. STEFFENSEN.

422. **Advanced Parasitology.** Advanced study of modern methods in helminthology. 1 unit. Prerequisite: Zoology 321 or equivalent. KRUIDENIER.

424. **Invertebrate Taxonomy.** Individual problems in taxonomy of invertebrates. 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Zoology 304. MATTESON.

425. **Experimental Parasitology.** Same as Veterinary Medical Science 425. A broadly based consideration of the relation of parasites to their hosts and to their environments, and of the factors which influence these relationships. 1 unit. Prerequisite: A laboratory course in parasitology or protozoology; organic chemistry; Chemistry 350; biochemistry and statistics are recommended. LEVINE, SILVERMAN.

433. **Embryology.** A study of initial differences in developing systems and interactions leading to more complex differences. May be elected in successive years. ½ unit. Maximum credit for master's candidates, one unit; for doctoral candidates, three units. Prerequisite: Zoology 333 and 367. WATTERSON.

441. **Advanced Comparative Physiology.** See Physiology 441. ½ unit. Prerequisite: Consent of instructor. STAFF.

442. **Advanced Comparative Physiology Laboratory.** See Physiology 442. 1 unit. Prerequisite: Physiology 402, 403, and 404; credit or registration in Physiology 441.

444. **Concepts in Ethology.** Group discussion of problems such as stimulus filtering, spontaneity, and stereotyped motor patterns, with a new topic each semester. ½ unit. Prerequisite: Zoology 346. BANKS.

445. **Seminar in Fish and Wildlife Ecology.** Modern ecological principles and concepts to specific problems in fisheries and wildlife. Offered in 1969-1970 and in alternate years. ½ unit. Prerequisite: Zoology 342 or 345, or equivalent.

446. **Physiological Ecology.** Physiological adjustments and responses of organisms to their environment. 1 unit. KENDEIGH.

451. **Advanced Cellular Physiology.** See Physiology 451. ½ unit. Prerequisite: Consent of instructor. STAFF.

467. **Experimental Embryology.** 1 unit. Prerequisite: Zoology 367. WATTERSON.

490. **Individual Research.** For master's degree candidates who elect to write a research report rather than a thesis. No more than three units may be included in the master's degree program. ½ to 3 units. Prerequisite: Consent of adviser. STAFF.

499. **Thesis Research.** 0 to 4 units. Work in the following fields is offered for students registered in Zoology 499:

Anatomy, Physiology, and General Classification of Vertebrates: Vertebrate Anatomy, H. SMITH; Endocrinology, HALL, NALBANDOV; Functional Anatomy, FRAZZETTA; Histology, DAVENPORT; Ultrastructure, HALL; Vertebrate Physiology, HEATH, PROSSER.

Anatomy, Physiology, and General Classification of Invertebrates: Helminthology, KRUIDENIER, LEVINE, SILVERMAN; Invertebrate Zoology, MATTESON,

Sweeney; Invertebrate Physiology, Prosser, Sweeney; Parasitology, Alger, Kruidenier, Silverman; Protozoology, Small.

Embryology and Basic Knowledge of Cells and Tissues: Cytology, Davenport; Embryology and Regeneration, Davenport, Watterson; Toxicology, Ingle.

Principles of Ecology, Principles of Taxonomy, Natural History: Ecology, Ghent, Kendeigh, King, Willson; Ethology, Banks, Hirsch, Salmon; Herpetology, H. Smith; Ichthyology, Shoemaker, P. Smith; Limnology, Bennett, Matteson; Mammalogy, Hoffmeister, Lee; Ornithology, Kendeigh, Willson; Wildlife Management, Kendeigh, Sanderson, Shoemaker.

Genetics and Evolution: Genetics and Evolution, Brown, Dawson, Kitzmiller, Nanney; Vertebrate Phylogeny and Paleontology, Bader, Frazzetta.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **General Seminar.** For members of the staff and graduate students. Required of all graduate students, but also open to seniors whose major is zoology. No credit. Attention is called to the following special clubs and seminars, some of which are interdepartmental: Animal Ecology Club, Genetics Seminar, Endocrinology Seminar, and Parasitology-Protozoology Seminar.

301. **General Physiology.** See Physiology 301. 1 unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent; one year each of college-level mathematics and physics; chemistry through organic.

302. **Experimental Animal Physiology.** See Physiology 302. 1 unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent; one year each of college-level mathematics and physics; chemistry through organic.

303. **Individual Topics.** For those who wish to study individual problems. Graduate students may register for topics involving individual work not assigned in other courses. Laboratory, conferences, and readings. ½ or 1 unit. Prerequisite: Two years of zoology or consent of department. Staff.

304. **Field and Systematic Zoology.** Collection, preservation, and identification of lower vertebrates and land and fresh-water invertebrates; habits and life histories of selected forms. 1 unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent; consent of instructor. Matteson.

305. **Principles of Systematic Zoology.** Theory and practice in proper procedure for formation and for determination of status names for classification of animal populations. ½ unit. Offered in 1969-1970 and in alternate years. Prerequisite: Consent of instructor. H. Smith.

306. **Biology for Teachers.** See Botany 306. ½ unit. Prerequisite: Botany 100 and Zoology 104, or a year course in general biology.

312. **Endocrinology.** See Physiology 312. ¾ unit. Prerequisite: Zoology 301 or a course in biochemistry; consent of instructor. Gorski.

313. **Experimental Endocrinology.** See Physiology 313. ½ unit. Prerequisite: Credit or registration in Physiology or Zoology 312; consent of instructor. Gorski.

318. **Protozoology.** Basic treatment of the morphology, physiology, and systematics of the protozoa; also consideration of their evolution, ecology, morphogenesis, sexual phenomena, genetics, and parasitism, with life histories of selected free-living and parasitic forms. 1 unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent. Small.

320. **Invertebrate Zoology.** Invertebrates; structure and development. Application of biological principles. Specific and comparative morphology of the invertebrates;

coordination of structure and function, origin, development, and life histories. 1 unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent. SWEENEY.

321. **Parasitology.** Worm parasites, life cycles, morphology, taxonomy, environmental relations. Lecture, laboratory, technique, readings, quiz, demonstrations, and problems. 1 unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent. KRUIDENIER.

324. **Vertebrate Paleontology.** Same as Geology 324. Phylogeny, morphology, and ecology of the fossil vertebrates. Lecture, laboratory, and field trips. ½ unit. Offered in 1968-1969 and in alternate years. Prerequisite: Zoology 232 or Geology 102. BADER.

330. **Practical Microtechnique.** An introduction to microscopy, microphotography, and histological technique. ½ unit. Prerequisite: Histology or embryology and consent of instructor. ALGER, KRUIDENIER.

331. **Experimental Cytology.** See Botany 331. 1 unit. Prerequisite: Biology 151, 210, or 251; consent of instructor. DAVENPORT, STEFFENSEN.

332. **Advanced Vertebrate Zoology.** Vertebrate morphology; comparative anatomy, evolution, and function of vertebrate organ systems, with special emphasis on the evolution, anatomy, and function of the skeletal and nervous systems. Lectures and laboratory. 1 unit. Prerequisite: Zoology 232. FRAZZETTA.

333. **Vertebrate Embryology.** The development of the vertebrate body and its organs. 1 unit. Prerequisite: Zoology 232. WATTERSON.

335. **Ornithology.** Structure, functions, environmental relations, habits, life history, and identification of birds. Laboratory during the first eight weeks and field trips during the last eight weeks of the semester. ½ unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent. KENDEIGH, WILLSON.

336. **Mammalogy.** Classification, distribution, life history, evolution, and identification of mammals. Lecture, laboratory, and field work. 1 unit. Prerequisite: Zoology 232. HOFFMEISTER, LEE.

337. **Ichthyology.** Classification, structure, evolution, distribution, and life history of fish. Lectures, laboratory, and field work. ½ unit. Prerequisite: Zoology 232. SHOEMAKER.

338. **Herpetology.** Classification, distribution, life history, and identification of reptiles and amphibians, particularly those of the United States. Lectures, laboratory, and field work. ½ unit. Offered in 1968-1969 and in alternate years. Prerequisite: Zoology 232. H. SMITH.

340. **Natural History of the Vertebrates.** Identification, distribution, adaptation, food, ecology, and life history with emphasis on vertebrates of Illinois. Lectures, laboratory, and field work. 1 unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent; consent of instructor. WILLSON.

341. **Field Ecology.** During spring vacation, study of biotic communities, mammals, birds, reptiles, amphibia, fishes, and invertebrates in various sections of North America. Outdoor camping and cooking. Transportation in University cars. ¼ unit. Prerequisite: Credit or registration in one of the following: Zoology 304, 335, 336, 337, 338, 340, 345; consent of instructor. KENDEIGH, SHOEMAKER.

342. **Wildlife Management and Conservation.** Size and measurement of animal populations, factors, affecting reproduction and mortality, life history, management policies for fish, mammals, and birds. ½ unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent. SHOEMAKER.

343. **Limnology.** Fresh-water biology. Study of the lake, pond, and river with emphasis on the physical environment as well as on the plants and animals which live

in fresh water. Lectures, discussions, laboratory, and field work. 1 unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent; consent of instructor. MATTESON.

345. Animal Ecology. Composition, dynamic development, and distribution of biotic communities. ¾ or 1 unit. Students enrolling for three-fourths unit are required to do field work on six Saturdays (recommended for those also enrolled in Zoology 342); those enrolling for one unit are required to do field or laboratory work every Saturday, including one weekend camping trip; estimated expense, $8.50. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent. KENDEIGH.

346. Ethology. The behavior of animals as interpreted through comparative studies and experimentation. Laboratory consists of observation, experiments, occasional field trips, and an individual term project. Lecture, ½ unit; lecture and laboratory, 1 unit. Prerequisite: One year of 300-level courses in zoology, physiology, or psychology; consent of instructor for laboratory enrollment. BANKS.

361. Individual and Group Behavior of Honey Bees. See Horticulture 361. ½ unit. Prerequisite: One semester of entomology or zoology. JAYCOX.

367. Analysis of Development. Advanced study of basic problems in developmental biology. Major emphasis is placed on interactions at molecular, fine structural, and cellular levels, and the genetic and metabolic mechanisms by which these interactions are controlled in plants and animals. Theories of differentiation are critically examined in the light of recent research. Lectures, discussions, outside readings, and student reports. 1 unit. Prerequisite: Biology 211 or Zoology 333; Biology 210; organic chemistry.

369. Introduction to Human Ecology. Same as Anthropology, Geography, Health Education, Physiology, Sociology, and Veterinary Medical Science 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations, and physiological, psychological, and sociological adjustments to environment, regulation of populations, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology; one year of anthropology, geography, geology, or sociology. KENDEIGH, SHIMKIN, STAFF.

LINGUISTICS

(Including Arabic, Burmese, Chinese, Hindi, Indonesian, and Japanese)

The Department of Linguistics offers a graduate program leading to the Master of Arts and Doctor of Philosophy. The following fields of linguistics are available for concentration: descriptive linguistics, historical linguistics, applied linguistics, interdisciplinary study in psycholinguistics, ethnolinguistics, experimental phonetics, and mathematical linguistics.

Undergraduate preparation for the study of linguistics should include the equivalent of at least three years of foreign language experience; for historical linguistics, a broad background in the humanities and social studies; and for descriptive linguistics, the equivalent of good undergraduate training in mathematics and the sciences. Students applying for admission should have at least a 4.0 grade-point average for that portion of the work which represents the last sixty hours earned toward the bachelor's degree. Applications of students with a grade-point average between 3.5 and 3.99 are considered on an individual basis.

Master of Arts. Candidates for this degree must earn eight units, of which six units must be in linguistics and must include Linguistics 302, 401, and 402.

In addition to fulfilling the general requirements of the Graduate College, the student must pass the reading examination in one foreign language, pass the comprehensive qualifying examination in general linguistics (and special subjects, if appropri-

ate), and must submit a satisfactory master's essay to the department; admission to the qualifying examination is contingent upon success in the language examination.

Doctor of Philosophy. Admission to candidacy for this degree normally requires a grade-point average of 4.5 or better for all graduate work in linguistics. Candidates for this degree must complete at least twenty-four units of graduate work, or sixteen units beyond the master's degree. The minimum twenty-four units must include the course requirements listed above for the master's degree (or their equivalent), Linguistics 404, advanced work in both phonology and syntax, and eight units of Linguistics 499.

Students are encouraged to attend at least one summer session of the Linguistic Institute of the Linguistic Society of America. Up to four units of credit granted by the host university under this program may be transferred. Students of descriptive linguistics also are strongly urged to establish a vested interest and a firm basic foundation in some particular language or language family at as early a point as possible in their graduate career.

Candidates must demonstrate proficiency in two languages other than English and must pass the comprehensive qualifying examination (mentioned above for the master's degree), preferably after the first year of graduate work, unless they have already qualified for the Master of Arts in Linguistics.

Linguistically oriented courses in related departments may be counted toward the major if approved by the adviser. The head of the department acts as general adviser to each student until he selects his field of concentration, at which time he comes under the guidance of an adviser in his special area.

GRADUATE FACULTY

Professors: R. B. Lees (Head of Department), J. H. D. Allen, J. B. Casagrande, C. L. Dawson, H. R. Kahane, M. A. Morínigo, C. E. Osgood.

Associate Professors: Katharine O. Aston, F. M. Jenkins, F. K. Lehman, H. S. Maclay.

Assistant Professors: C.-W. Kim, T. M. Lightner, J. Yegerlehner, W. R. Zemlin, A. M. Zwicky.

Linguistics

COURSES FOR GRADUATES

401. **Syntax.** Critique of traditional and contemporary theories of syntactic structure; systematic introduction to transformational grammar. 1 unit. Prerequisite: Linguistics 300 or equivalent. Geis, Zwicky.

402. **Phonology.** Examination of language-specific phonological problems with a view toward formulating a language-independent theory of phonology. 1 unit. Prerequisite: Linguistics 301 or consent of instructor. Lightner.

403. **Seminar in Linguistic Analysis.** Discussion of advanced topics of current interest in descriptive linguistics. 1 unit. May be repeated for credit with consent of instructor. Prerequisite: Linguistics 401. Zwicky.

404. **Practicum.** Classroom- and homework-solving of assorted problems in syntactic and phonological analysis of many languages. 1 unit. Prerequisite: Linguistics 401 and 402.

407. **Advanced Topics in Mathematical Linguistics.** The hierachy of automata and the hierarchy of grammars; equivalence theorems and undecidability theorems; recognition procedures. 1 unit. Prerequisite: Linguistics 307 or equivalent. Zwicky.

408. Russian Phonology. Same as Russian 408. Synchronic examination of the phonological system of modern Russian and of its interrelation with the syntactic and lexical systems; brief discussion of the historical development of the phonological system. 1 unit. Prerequisite: Consent of instructor. LIGHTNER.

409. Field Methods in Linguistics. Same as Anthropology 409. The recording and analysis of a spoken language with a native speaker of that language as an informant. 1 unit. Prerequisite: Credit or registration in Linguistics 401. LEHMAN, YEGERLEHNER.

410. Advanced Field Methods in Linguistics. Same as Anthropology 410. Advanced analysis of a spoken language with a native speaker of that language as an informant. 1 unit. Prerequisite: Linguistics or Anthropology 409, or equivalent. LEHMAN, YEGERLEHNER.

411. Methods in Historical Linguistics. Advanced analysis of genetic comparison and reconstruction, linguistic borrowing, linguistic geography, etymology, and related topics. 1 unit. Prerequisite: Linguistics 302 or 315. HOCK, KAHANE.

412. Research Seminar in Historical Linguistics. Research work in etymology, linguistic geography, and historical syntax. 1 unit. Prerequisite: Linguistics 411 or consent of instructor. KAHANE.

415. Seminar in Indo-European Linguistics. Discussion and research paper on topics in Indo-European languages, their history, origins, development, and migration. 1 unit. HOCK.

419. Contrastive Linguistics. Same as Rhetoric 419. A critical survey of contemporary linguistic models with special reference to their relevance in preparing contrastive analyses of languages; detailed discussion on contrastive analyses of English and selected non-Western languages at different linguistic levels. ½ or 1 unit. Prerequisite: Linguistics 300 or consent of instructor. ASTON.

420. Linguistic Phonetics. Principles of scientific description of the phonic aspect of language; distinctive features and phonetic alphabets; relations between phonetics and other linguistic levels; and inventory of speech sounds. 1 unit. Prerequisite: Linguistics 301 or equivalent. KIM.

421. Seminar in Phonetic Theories. Theories of speech production; motor theory and linguistic change; acoustical correlates of vocal-tract configurations; theories of speech perception; and a model of universal phonetics. 1 unit. Prerequisite: Linguistics 301 or equivalent. KIM.

424. Linguistics and Communication. Same as Communications 424. The communicative function of language with emphasis on the application of linguistic theories and methods to problems in human communication. 1 unit. MACLAY.

425. Psycholinguistics. Same as Communications and Psychology 425. A critical survey of methods and theories in the psychological study of the communication process with emphasis upon linguistic, information-theory and learning-theory approaches, psycholinguistic analysis of language decoding and encoding, and the development and measurement of symbolic processes, including meaning. 1 unit. Prerequisite: Consent of instructor. OSGOOD.

426. Research Seminar in Psycholinguistics. Same as Communications and Psychology 426. Critical discussion of research problems to which psycholinguistic theories and techniques can be applied. Students taking this course are expected to plan, execute, and report an original piece of research in this area during the course. ½ or 1 unit. Prerequisite: Linguistics 425; consent of instructor. MACLAY, OSGOOD.

450. Linguistics and the Study of Meaning. A consideration of those aspects of meaning which are the concern of linguistic theory. 1 unit. Prerequisite: Linguistics 300. YEGERLEHNER.

462. **Introduction to Romance Linguistics.** Same as French, Spanish, Italian, and Portuguese 462. Comparative and historical analysis of the Romance languages. ½ unit. Prerequisite: Four semesters of a Romance language or Latin, or equivalent. KAHANE.

473. **Seminar in Phonetics.** Same as Speech 473. Advanced study in phonetic theory and noninstrumental phonetic investigation. 1 unit. Prerequisite: Consent of instructor. ZEMLIN.

475. **Experimental Phonetics, I.** Same as Speech 475. Theoretical consideration of speech as motor behavior, with special reference to physiological investigations of normal respiration, phonation, and articulation. Survey of the experimental literature. 1 unit. Prerequisite: Consent of instructor. ZEMLIN.

476. **Experimental Phonetics, II.** Same as Speech 476. Theoretical consideration of speech as an acoustical phenomenon, with special reference to acoustical investigations of voice and speech sounds. Survey of the experimental literature. 1 unit. Prerequisite: Consent of instructor. ZEMLIN.

477. **Measurement of Speech, I.** Same as Speech 477. Principles and methods of measuring speech action. Special action recorders and transducers; techniques of analysis; problems of experimental design. Laboratory experimentation. 1 unit. Prerequisite: Consent of instructor; credit or registration in Linguistics 475. ZEMLIN.

478. **Measurement of Speech, II.** Same as Speech 478. Principles and methods of measuring the acoustical phenomena of speech. Oscillographic measurement of vocal variables; special instruments and media for automatic graphic recording; analysis of data; problems of experimental design. Laboratory experimentation. 1 unit. Prerequisite: Consent of instructor; credit or registration in Linguistics 476. ZEMLIN.

481. **Topics in Syntactic Theory.** Investigation of syntactic universals; recent developments in the theory of syntax. 1 unit. Prerequisite: Linguistics 317, 387, or 401; consent of instructor. ZWICKY.

482. **Topics in Phonological Theory.** Continuation of Linguistics 402. Special topics and individual papers are assigned. 1 unit. Prerequisite: Linguistics 402 or equivalent. LIGHTNER.

490. **Special Topics in Linguistics.** Individual studies in the areas of linguistics not covered by regular course offerings. ½ to 2 units.

499. **Thesis Research.** 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Introduction to Linguistics.** Same as Anthropology 300. An introduction to the science of descriptive linguistics. ½ unit. Prerequisite: Fulfillment of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. STAFF.

301. **Introduction to General Phonetics.** An introduction to the main branches of general phonetics and phonological theory; emphasis on analysis of non-Western languages and research techniques. ½ unit. KIM.

302. **Comparative Linguistics.** An introduction to the historical aspects of language. ½ unit. Prerequisite: Fulfillment of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. KAHANE.

303. **Non-Western Linguistic Structures.** Intensive study of linguistic structure of a selected non-Western language. May be repeated for credit with consent of instructor. 1 unit.

305. Introduction to Applied Linguistics. An introduction to the applications of general linguistic theory to the specific fields of stylistics, theory of translation, contrastive analyses, and the teaching and learning of foreign (and second) languages. Practical assignment work. ¾ unit. Prerequisite: Consent of instructor. KACHRU.

307. Introduction to Mathematical Linguistics. Same as Anthropology 307. Principles of set theory, logic and formal systems, group theory, and automata theory; introduction to the formal theory of grammars. 1 unit. Prerequisite: Linguistics 300.

308. Comparative Grammar of Greek and Latin. See Greek 308. ½ unit. Prerequisite: Latin 202 or equivalent; credit or registration in Greek 202.

315. Introduction to Indo-European Linguistics. Introductory survey of Indo-European languages and their mutual relations; exemplification of methods of reconstruction through examples from Indo-European languages; discussion of theories about the original home, culture, and society of the Indo-Europeans; introductory presentation of the sound laws of the major Indo-European languages and of the overall structure of Indo-European morphology. 1 unit. Prerequisite: Fulfillment of the language requirement of the College of Liberal Arts and Sciences. HOCK.

316. Structure of the French Language. Same as French 316. A general survey of the linguistic structure of modern standard French, including phonology, morphology, and syntax. Emphasis is on the differences between its spoken and written forms. ¾ unit. Prerequisite: French 313 or equivalent training in phonetics. JENKINS.

317. Languages of the World. Same as Anthropology 317. A survey of the main language families of the world from both genetic and typological points of view, with special reference to the theory of syntactic descriptions. ½ or 1 unit. Prerequisite: Linguistics 300 or consent of instructor. YEGERLEHNER.

325. Introduction to Psycholinguistics. Same as Communications 325. An introductory survey of psychological and linguistic approaches to the study of communication. 1 unit. Prerequisite: An introductory course in linguistics or in psychology. MACLAY.

338. Philosophies of Language. Same as Philosophy 338. A study of the development of philosophical problems about language and the treament of them from antiquity through the nineteenth century. ¾ or 1 unit. Prerequisite: One course in philosophy. FABER.

340. History of Linguistics. Survey of linguistic theories from ancient to modern times; special emphasis on comparative grammar and the development of structural linguistics; extended discussion of at least one other period. 1 unit. Prerequisite: Linguistics 300 or equivalent.

350. Sociolinguistics. A critical study of the sociologically oriented general linguistic theories with special reference to language varieties, language attitudes, language diversity, language standardization, linguistics geography, language and political roles (language loyalty). Emphasis on research methodology and techniques. Concentration on South Asia. ½ or 1 unit. Prerequisite: Linguistics 300 or consent of instructor. KACHRU.

351. Area Linguistics. Introduction to area classification, linguistic covergence, and borrowing; the Southeast Asia *Sprachbund;* phonological, morphological, and syntactic convergence. 1 unit. Prerequisite: Linguistics 300. LEHMAN.

370. Language, Culture, and Society. Same as Anthropology and Communications 370. An examination of the social and cultural functions of language, with

particular emphasis on the application of linguistic methods and findings to selected problems in the social sciences. ½ or 1 unit. CASAGRANDE.

375. **Speech Science, I.** Same as Speech 375. Introduction to the anatomical and physiological characteristics of the normal speech and hearing mechanisms, and to the fundamental acoustics of speech. ½ unit. Prerequisite: Speech 109 or 301 or consent of instructor. ZEMLIN.

376. **Speech Science, II.** Same as Speech 376. Consideration of the physiology of the speaking act, the acoustical characteristics of voice and speech sounds, and the hearing of speech. ½ unit. Prerequisite: Speech 375 or consent of instructor. ZEMLIN.

380. **Introduction to Slavic Linguistics.** Same as Slavic 380. Changes in phonology and morphology from Indo-European to Common Slavic; geographical distribution of Slavic languages and dialects, prehistory and early history of the Slavs, and Balto-Slavic linguistic relationships. ¾ unit. DAWSON.

382. **Introduction to Sanskrit Linguistics, I.** The sounds and alphabet of Sanskrit; introduction to grammar, with drill and readings; sandhi rules; reading: Nala and Damayanti. 1 unit. Prerequisite: Linguistics 300; consent of instructor.

383. **Introduction to Sanskrit Linguistics, II.** Further grammar and reading; consideration of Sanskrit from one or more of the following points of view: (1) comparative Indo-European linguistics, (2) Indology, (3) Paninian linguistics, (4) Western linguistic theories, (5) transformational-generative grammar. 1 unit. Prerequisite: Linguistics 382.

387. **The Structure of English.** Same as English 387. Critical evaluation of traditional and structuralist grammatical descriptions; introduction to transformational grammatical studies; detailed survey of a transformational syntax of English; brief introduction to generative phonology and morphophonemic analysis of English, especially stress. ¾ unit. GEIS.

388. **Linguistics in Language Learning, I.** Same as Rhetoric 388. The application of linguistic methods in the learning of a second language, with special emphasis on the learning of English. ¾ unit. Prerequisite: Two years of a foreign language, or equivalent; consent of instructor. ASTON.

389. **Linguistics in Language Learning, II.** Same as Rhetoric 389. Applied linguistics in teaching and learning English as a second language, with special emphasis on the application of some principles of psycholinguistics, sociolinguistics, and ethnolinguistics along with the related disciplines of education, psychology, and anthropology to structured teaching/learning situations. ¾ unit. Prerequisite: Linguistics 388. ASTON.

Arabic

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. **Intermediate Arabic, I.** First term of second year of work in the Arabic language, with drill for more advanced conversational fluency; introduction to a greater variety of styles and levels of discourse and usage, increasing study of the written language, and more formal grammar. ½ unit. Prerequisite: Arabic 202 or equivalent. ABDO.

304. **Intermediate Arabic, II.** Concentration upon ability to engage in reasonably fluent discourse in Arabic, on comprehensive knowledge of formal grammar, and on ability to read ordinary written Arabic. ½ unit. Prerequisite: Arabic 303 or equivalent. ABDO.

305. **Advanced Arabic, I.** Reading selections from literary works; selections from

political, social, historical, and economic writings. ½ unit. Prerequisite: Arabic 304 or equivalent. ABDO.

306. **Advanced Arabic, II.** A continuation of Arabic 305. Further reading in literary sources as well as in history, economics, and politics. ½ unit. Prerequisite: Arabic 305 or equivalent. ABDO.

Burmese

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. **Intermediate Burmese, I.** Introduction to a wider variety of styles and contexts of discourse and usage. Written Burmese and an orderly view of Burmese grammar. ½ unit. Prerequisite: Burmese 202 or equivalent. LEHMAN.

304. **Intermediate Burmese, II.** Concentration upon ability to engage in active and reasonably fluent discourse in Burmese, on the grammar of sentence formation and ability to read ordinary Burmese texts. ½ unit. Prerequisite: Burmese 303 or equivalent. LEHMAN.

Chinese

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. **Intermediate Chinese, I.** First term of second year of work in Chinese language, with drill for more advanced conversational fluency; introduction to a greater variety of styles and levels of discourse and usage, increasing study of the written language, and more formal grammar. ½ unit. Prerequisite: Chinese 202 or equivalent. CHANG.

304. **Intermediate Chinese, II.** Concentration upon ability to engage in fluent discourse in Chinese, on comprehensive grammatical knowledge, and on ability to read any ordinary simple text in Chinese. ½ unit. Prerequisite: Chinese 303 or equivalent. CHANG.

305. **Advanced Chinese, I.** Reading and translation of graded selections from modern Chinese literary and journalistic writing. ½ unit. Prerequisite: Chinese 304 or equivalent. CHANG.

306. **Advanced Chinese, II.** Reading in modern Chinese literary and journalistic writings; introduction to classical Chinese to prepare students of modern Chinese to understand classical forms and quotations occuring in vernacular text and to use dictionaries and reference works. ½ unit. Prerequisite: Chinese 305 or equivalent. CHANG.

Hindi

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. **Intermediate Hindi, I.** First term of second year of work in the Hindi language, with drill for more advanced conversational fluency; introduction of a greater variety of styles and levels of discourse and usage, increasing study of the written language, and more formal grammar. ½ unit. Prerequisite: Hindi 202 or equivalent. SUBBARAO.

304. **Intermediate Hindi, II.** Concentration upon ability to engage in reasonably fluent discourse in Hindi, on comprehensive knowledge of formal grammar, and

on ability to read ordinary texts in Hindi. ½ unit. Prerequisite: Hindi 303 or equivalent. SUBBARAO.

305. **Advanced Hindi, I.** A detailed analysis of formal grammar of Hindi and concentration on readings from Hindi literature, especially the *Bhakti* period and the *Adhunik* period; a survey of the growth of main literary forms of Hindi; introduction to styles and registers of Hindi. All students are required to work at least one hour with a native informant and/or in the language laboratory. ½ unit. Prerequisite: Hindi 304 or consent of instructor. SUBBARAO.

306. **Advanced Hindi, II.** A survey of the history of Hindi language and literature and its more important dialects, e.g., Brajbhasha, Awadhi, etc.; readings from different periods of Hindi literature; introduction to main trends and influences on modern Hindi literature. All students are required to concentrate on a restricted area of Hindi language or literature for specialization, and to work with an informant for greater fluency in conversational and formal Hindi. ½ unit. Prerequisite: Hindi 305 or consent of instructor. SUBBARAO.

Indonesian

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. **Intermediate Indonesian, I.** First term of second year of work in the Indonesian language, with drill for more advanced conversational fluency; introduction to a greater variety of styles and levels of discourse and usage, increasing study of the written language, and more formal grammar. ½ unit. Prerequisite: Indonesian 202 or equivalent. YERGERLEHNER.

304. **Intermediate Indonesian, II.** Concentration upon ability to engage in reasonably fluent discourse in Indonesian, on comprehensive knowledge of grammar, and on ability to read ordinary written Indonesian. ½ unit. Prerequisite: Indonesian 303 or equivalent. YERGERLEHNER.

Japanese

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. **Intermediate Japanese, I.** First term of second year or work in the Japanese language, with drill for increased conversational fluency; introduction to a greater variety of styles and levels of discourse and usage, increasing study of the written language, and more formal grammar. ½ unit. Prerequisite: Japanese 202 or equivalent. MAKINO.

304. **Intermediate Japanese, II.** Concentration upon ability to engage in reasonably fluent discourse in Japanese, on comprehensive view of formal grammar, and on ability to read simple written Japanese. ½ unit. Prerequisite: Japanese 303 or equivalent. MAKINO.

305. **Advanced Japanese, I.** Course for advanced knowledge of Japanese with emphasis on reading. ½ unit. Prerequisite: Japanese 304 or equivalent. MAKINO.

306. **Advanced Japanese, II.** Course for advanced knowledge of Japanese with emphasis on reading. ½ unit. Prerequisite: Japanese 305 or equivalent. MAKINO.

MARKETING

Graduate work may be taken in the field of marketing for a major or a minor for the Master of Science and for the Doctor of Philosophy. To do major work in this

field, a student must have a grade-point average of at least 4.0 and adequate undergraduate training in business and marketing, quantitative analysis, and the social sciences. The program of each student, including the selection of an appropriate minor, must be approved by the graduate adviser or head of the Department of Marketing.

GRADUATE FACULTY

Professors: R. Ferber, R. M. Hill, F. M. Jones, R. V. Mitchell, H. G. Wales.
Associate Professors: R. D. Millican, J. L. Simon, S. Sudman.
Assistant Professors: J. B. Cohen, D. M. Gardner.

COURSES FOR GRADUATES

401. Marketing Theory and Systems. A detailed study of macro and micro marketing systems and the various approaches to marketing theory; attention is given to general systems theory, the nature of marketing systems, system adaptation to the environment, concepts of theory, and major approaches to macro and micro theory in marketing. 1 unit.

402. Development of Marketing Thought. The emphasis in this course is placed on an analysis of marketing thought from the late 1800's to the present. Although attention is directed primarily to general marketing and marketing management, consideration is also given to major contributions in selected areas of marketing. The literature and scholars selected are evaluated both as reflections of their times and as contributions or contributors to contemporary thought. 1 unit. Prerequisite: Marketing 401.

407. Comparative Marketing Systems. Examination of comparative marketing systems. Topics include specification and identification of structural elements of systems, analysis of static and dynamic properties, methods of analyzing systems such as input-output and flow analysis, the role of marketing in comparative economic systems, and the role of marketing in developing countries. 1 unit. Prerequisite: Marketing 401.

415. Foundations of Consumer Behavior. A study of basic factors influencing consumer behavior. Attention is focused on psychological, sociological, and economic variables, including motivation, learning, attitude, personality, small groups, social class, demographic factors, and culture, to analyze their effects on purchasing behavior. 1 unit.

416. Consumer Information Processing. Analysis of information flows between buyer and seller; informational properties of demand stimulation strategies are considered from the viewpoints of the firm, consumer, and society; consumer decision making is examined drawing upon the psychology and sociology of buyer motivation and social influence. 1 unit. Prerequisite: Marketing 415.

421. Marketing Strategy: Theoretical Foundations. A formal analysis of strategy drawing on concepts from the theory of games, decision theory, value theory, and information theory. Topics covered are elements of game models, classes of decision problems, games against nature, modern utility theory, information theory, group decision making, statistical decision theory, and linear and nonlinear optimization. 1 unit.

422. Marketing Strategy: Decision Models. The role of models in the design, implementation, and adjustment of seller strategy; application of simulation, programming, and other methods to the specification and solution of product price, promotion, and other marketing problems. Topics covered include the nature of models and model building, forecasting models, optimization models, and other decision models. 1 unit. Prerequisite: Marketing 421.

472. **Multivariate Methods in Marketing.** The use of multivariate statistical methods in marketing research. Topics covered include multiple regression and correlation, analysis of variance and covariance, canonical correlation, discriminant analysis, factor analysis, and simultaneous methods such as two-stage least squares and limited information likelihood. 1 unit. Prerequisite: Economics 470.

473. **Experimental Design.** Training in the design, execution, and interpretation of field and laboratory experimental research. Emphasis is placed on the evaluation of alternative designs, execution of problems, and interpretation of data; a review of illustrative research studies is made, an actual study is designed, and data is collected and interpreted. 1 unit.

474. **Survey Methods in Marketing Research.** An analysis of survey methods in marketing with emphasis on sample design, data collection, and data processing; an advanced course in the methods required to design, implement, and evaluate a research project. 1 unit. Prerequisite: Economics 171 or equivalent.

490. **Seminar in Marketing.** A special topics course in the general area of marketing. Topics are selected by the instructor at the beginning of each semester. 1 unit.

493. **Research in Special Fields.** ¼ to 2 units.

499. **Thesis Research.** Thesis or independent study in the field of marketing. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

Note: Marketing majors do not receive graduate credit for courses in the 300 series.

320. **Marketing Research.** An investigation of the development and applicability of information systems techniques to marketing problems. The marketing management process is analyzed; the underlying concepts related to the information needed to serve the processes are explored; and the incorporation of information resources into the management function is demonstrated. This course covers the use of behavioral sciences research methods, social processes and structure influences upon marketing activities, demographic variables, application of Bayesian decision theory, studies of promotional activity, simulation and programming models, planning models, and strategy formulation models which provide an analytical structure for the solution of marketing problems. ½ unit. Prerequisite: Marketing 201.

337. **Advertising and Sales Management.** Designed to enable the student, through directed and supervised investigation of selected psychological, economic, and sociological problems, to become acquainted with the methods of demand analysis and its application to the interrelationships of marketing management, advertising management, and sales management. Discussion of communication theory as it relates to the goals and means of winning patronage for the firm. Emphasis is on the effect, or control, of the communication process. Class discussion is focused upon literature in demand stimulation and communications and the testing of relevant hypotheses. ½ unit. Prerequisite: Marketing 201.

344. **Consumer Market Behavior.** An analysis of consumer motivation, buying behavior, market adjustment, and product innovation, including a survey of explanatory theories of consumer market behavior and producer reactions. This course covers behavioral aspects of the marketing process from the producer to ultimate user, or consumer. Fundamentals of product planning, development, engineering, and promotion are viewed as part of the total marketing program. Normative models of the decision-making process for winning patronage in intermediate, industrial, and consumer markets are considered. The decision-making process by consumers is evaluated with reference to psychological drives used by producers, middlemen, and consumers. ½ unit. Prerequisite: Marketing 201.

352. Pricing Policies. The essential nature of marketing decisions and pricing, marketing organization and the pricing process, price theories and pricing models; contributions of operations research and behavioral sciences to pricing analysis; the relationship of pricing objectives, methods, strategies, and policies to market behavior and the goals of the firm. ½ unit. Prerequisite: Marketing 201.

360. Marketing Logistics. The ecology, analysis, and development of integrated distribution systems; the application of quantitative tools, economic analysis, transportation and marketing management in the analysis, and interpretation and design of the physical flow of goods through marketing network alternatives. Attention is given to the theory of market structures, transport networks, location, and cost control. Consideration is also given to site selection, warehousing, inventory management, logistic communications networks, and data control models. ½ unit. Prerequisite: Marketing 201.

370. International Marketing. The role of enterprise, comparative marketing, and transport institutions and systems, and comparative marketing organizations and systems of administration in selected foreign countries and the United States; the managerial and operational problems of world enterprise, with emphasis on the role of ethnic and cultural differences in influencing marketing strategy. ½ unit. Prerequisite: Marketing 201; consent of instructor.

380. Advanced Marketing Management. The appraisal and diagnosis, organization and planning, action and control of commodity and product-service distribution, marketing analysis and systems, and demand stimulation; a survey of normative models for decision-making in a variety of marketing situations and systems; introduction to the behavioral theory of the firm and its application to different marketing targets, institutional settings, or market arrangements; discussion of the various analytical tools available to firms for appraising, diagnosing, organizing, planning, and formulating market strategies. Principles of behavioral sciences and quantitative techniques are emphasized. A terminal course that integrates the analysis of a wide range of marketing problems and situations. ½ unit. Prerequisite: Marketing 320 and 337.

Note: See also Business Administration 373, Electronic Data Processing for Business.

MATHEMATICS

(Including Statistics)

The Department of Mathematics offers graduate work leading to the Master of Arts or Master of Science in Mathematics and Doctor of Philosophy in Mathematics, Master of Science in the Teaching of Mathematics, and Master of Arts or Master of Science in Statistics and Doctor of Philosophy in Statistics. For information concerning applied mathematics, see page 285.

MATHEMATICS

For admission a beginning graduate student must have a grade-point average of 3.75. Applications of students with grade-point averages below 3.75 but above 3.5 are considered on an individual basis.

A student should have had twenty-three hours of undergraduate work in mathematics besides the usual freshman courses in algebra, trigonometry, and analytic geometry, including a one-year course in calculus and at least nine semester hours of more advanced work in one or more of the fields of algebra, geometry, topology, analysis, and number theory. The last requirement refers to courses equivalent to Mathematics 317-318, 327-328, 332-333, 347-348, 353-354, and 387.

Master of Arts or Master of Science in Mathematics. The departmental requirements for the master's degree in mathematics are as follows: of the eight units re-

quired for the degree, at least six must be in mathematics, at least three of them in approved 400-level courses. Mathematics 347-348 and at least one other basic year sequence at or above the intermediate level, normally one of the sequences 317-318, 327-328, 332-333, should be included. More than one-half of this last requirement should be fulfilled in previous undergraduate work. A master's thesis is not required.

Master of Science in the Teaching of Mathematics. Candidates for the Master of Science in the Teaching of Mathematics must earn four units in mathematics, two units in education, and two units in electives. To meet requirements for this degree, candidates must have completed, either as prerequisites to admission or as part of their graduate program, all of the following courses or their equivalents: Mathematics 302, 303, 306, 307, 317, 318, 343, 347. A student who has not completed at least two of these courses as an undergraduate can not expect to qualify for the Master of Science in the Teaching of Mathematics in one year. Required courses in education are History and Philosophy of Education 304 and 305 and Educational Psychology 311 and 312. The electives may be in mathematics, in education, or, in exceptional cases, in other fields. Students applying for admission must have a grade-point average of 3.75. Applications of students with grade-point averages below 3.75 but above 3.5 are considered on an individual basis. The adviser for this degree is Professor Wilson M. Zaring, 303 Altgeld Hall. See pages 45 and 46.

Doctor of Philosophy in Mathematics. The departmental requirements for the Doctor of Philosophy are as follows: the major subject is to be chosen from algebra, analysis, applied mathematics, geometry, logic, probability and statistics, topology; the student must choose two internal minors from this list, or one internal minor and one outside minor, or a full outside minor; the choice of the outside minor, whether split or full, must have the approval of the Department of Mathematics.

Before taking the preliminary examination, the student must present sixteen units or its equivalent with the approval of the department. Of these units, at least ten units must be in 400-level mathematics courses, except for a student with a full outside minor, eight such units suffice. The preliminary examination in mathematics is based on the student's major and internal minor subjects, but is also intended to test the student's breadth of knowledge in mathematics. In the case of a full or split outside minor, the minor department may give an independent examination, if it so chooses, or may establish other criteria for evaluation of the student's ability.

At least two 400-level courses are required for each internal minor. The following mathematics courses are typical of those which may be used to satisfy major or minor requirements, and are listed by fields. It is left to the discretion of the department, however, to decide which courses may be chosen to fulfill such requirements.

Algebra: 401-408, 415, 416, 422.
Analysis: 440-447, 449, 453-456, 468, 469, 487.
Applied Mathematics: 444, 455-460, 461, 463, 465, 487-489.
Geometry: 408, 420, 422-426, 428.
Logic: 410-413, 416.
Probability and Statistics: 451, 452, 461, 463, 470, 473, 474, 478.
Topology: 431-435, 438, 439.

Furthermore, Mathematics 490 and 493 may be used for major or minor requirements in all areas, subject to the approval of the department.

Every student who intends to work toward a degree of Doctor of Philosophy in Mathematics is expected to take a written qualifying examination within one year after completing his requirements for the master's degree; this examination is based on topics covered in Mathematics 317, 318, 347, 348. Furthermore, each student is expected to take the preliminary examination within one year after completing sixteen units of graduate work. The department may relax the requirements in the preceding two sentences, if special circumstances so warrant.

The language requirement must be met by demonstrating a reading proficiency in any two of the following three languages: French, German, and Russian.

STATISTICS

This program of study is developed for those who wish to concentrate on research in the theory of statistics, and to provide training in the theory and practice of statistical inference from quantitative data. It also provides an appropriate minor for those who wish to develop competence in an area of application of statistics, such as agronomy, biology, chemistry, economics, education, geology, physics, or psychology. The program is administered by the Department of Mathematics with the help of a small interdepartmental advisory committee.

For admission to full standing, a beginning graduate student must have a grade-point average of not less than 3.75. Applications of students with grade-point averages below 3.75 but above 3.5 are considered on an individual basis. The completion of a thorough course in calculus is also a prerequisite to admission. A course in advanced calculus, while not required, is helpful. Students are admitted on limited status.

Master of Arts or Master of Science in Statistics. A candidate for the master's degree in statistics, in addition to satisfying the general requirements of the Graduate College, must complete the following courses: (1) Mathematics 315 and 347, or equivalent; (2) four units of statistics of which at least two must be 400 courses; (3) two units in mathematics or an area of application; (4) two units of electives approved by the adviser.

However, so long as a student fulfills the standard requirements for graduate degrees (see pages 44 and 45), he can complete some of these course requirements as an undergraduate, or by outside reading, or by any other means approved by the Department of Mathematics.

Doctor of Philosophy in Statistics. The thesis for the Doctor of Philosophy must show capacity for important original contributions to one or more of the following: development of new statistical ideas and methods; improvement of applications of statistical methods; and new uses of statistical methods in some field of application. The work of individual students is supervised by one adviser if the courses referred to as electives in the following are taken in general statistics; otherwise by two advisers, one representing the field of general statistics and one representing mathematics or a field of application.

A candidate for the Doctor of Philosophy in Statistics, in addition to satisfying the general requirements of the Graduate College (note the requirement of a minor of at least two units in an area of study other than statistics or mathematics), must complete the following courses: (1) Mathematics 315, 347, or equivalent; (2) eight units of statistics of which at least four must be courses at the 400 level, selected from a list of courses prepared by the Department of Mathematics and including all courses in statistics listed jointly by the Department of Mathematics and areas of application; (3) four units in mathematics or an area of application, not more than two of which should emphasize training in statistics; (4) six units of electives approved by the adviser.

Candidates for a Doctor of Philosophy taking a sole minor in statistics are expected to have completed a course in calculus and are required to complete four units of work in statistics having calculus as prerequisite. Those taking a first or second minor in statistics are required to complete at least two units of work in statistics having calculus as prerequisite.

GRADUATE FACULTY

Professors: P. T. Bateman (Head of Department), R. G. Bartle, C. R. Blyth, W. W. Boone, D. L. Burkholder, S. S. Cairns, R. W. Carroll, K. T. Chen, E. C. Dade, M. M. Day, J. L. Doob, D. B. Gillies, S. I. Goldberg, J. W. Gray, W. Haken, Mary-Elizabeth Hamstrom, M. H. Heins, F. E. Hohn, P. W. Ketchum, R. G. Langebartel, H. Levy, C. W. Mendel, D. E. Muller, H. Osborn, R. E. Pingry, I. Reiner, L. A. Rubel, E. J. Scott, J. L. Selfridge,

M. Suzuki, G. Takeuti, T. W. Ting, W. J. Trjitzinsky, H. E. Vaughan, J. H. Walter, R. A. Wijsman.

Associate Professors: K. I. Appel, R. B. Ash, E. R. Berkson, R. L. Bishop, P. G. Braunfeld, Josephine H. Chanler, W. A. Ferguson, L. L. Helms, R. P. Jerrard, F. B. Knight, H. Paley, E. T. Parker, A. L. Peressini, J. W. Peters, M. Rajagopalan, R. R. Rao, N. J. Rothman, J. J. Rotman, Jewell E. Schubert, P. M. Weichsel, E. C. Weinberg, W. M. Zaring.

Assistant Professors: S. K. Aggarwal, J. R. Alexander, Jr., J. W. Armstrong, A. Babakhanian, S. B. Bank, Felice D. Bateman, Geneva G. Belford, I. D. Berg, Astrid J. Berkson, B. C. Berndt, J. W. Brown, H. G. Diamond, V. C. Dumir, R. J. Faudree, R. L. Finney, R. W. Fossum, D. K. Friesen, C. G. Jockusch, R. P. Kaufman, L. R. McCulloh, T. G. McLaughlin, C. F. Osgood, J. T. Parr, Phyllis G. Parr, Irma Reiner, T. T. Robinson, D. R. Sherbert, J. E. Wetzel, K. G. Witz, P. D. Zvengrowski.

COURSES FOR GRADUATES

401. **Second Course in Abstract Algebra, I.** The Noether isomorphism theorem for groups; permutation groups; simplicity of the alternating group; Jordan-Holder theorem; Euclidean rings; fundamental theorem of Galois theory. 1 unit. Prerequisite: Mathematics 317 and 318.

402. **Second Course in Abstract Algebra, II.** Wedderburn theorem on semi-simple rings; fundamental theorem of finitely generated Abelian groups (with application to canonical forms for matrices); Krull-Schmidt theorem; tensor products; exterior algebra. 1 unit. Prerequisite: Mathematics 401.

403. **Theory of Rings.** Ideal theory in commutative rings; structure of noncommutative rings. 1 unit. Prerequisite: Mathematics 401, 402, or equivalent.

404. **Group Theory.** Structure of groups, derived groups, nilpotence and solvability, extensions and products. 1 unit. Prerequisite: Mathematics 401, 402, or equivalent.

405. **Theory of Fields.** Further development of the theory of fields covering topics from valuation theory, ideal theory, units in algebraic number fields, ramification, function fields, local class field theory. 1 unit. Prerequisite: Mathematics 401, 402, or equivalent.

406. **Homological Algebra.** An axiomatic treatment of the algebraic systems basic in topology. 1 unit. Prerequisite: Mathematics 401, 402, or equivalent.

407. **Group Representation Theory.** Representation of groups by linear transformations, group algebras, character theory, modular representations. 1 unit. Prerequisite: Mathematics 401, 402, or equivalent.

408. **Lie Groups.** 1 unit. Prerequisite: Mathematics 332, 404, 441.

410. **Logical Foundations of Mathematics, I.** A discussion of the logical and philosophical foundations of mathematics; considers propositional and first order functional calculi. 1 unit. Prerequisite: Mathematics 314, or 317, or 347, or Philosophy 333, or consent of instructor.

411. **Logical Foundations of Mathematics, II.** Continuation of Mathematics 410. Considers Henkin completeness theorem and Godel incompleteness theorem. 1 unit. Prerequisite: Mathematics 410.

412. **Recursive Function Theory.** Introduction to recursive functions, study of properties of recursive and recursively enumerable sets, degrees of unsolvability,

and the implications of the Church-Turing thesis. 1 unit. Prerequisite: Mathematics 410 or consent of instructor.

413. **Set Theory.** Zermelo-Fraenkel axiomatic set theory; basic concepts in set theory such as ordinal, cardinal, and rank are considered. 1 unit. Prerequisite: Mathematics 410.

415. **Advanced Topics in the Theory of Groups.** 1 unit. Prerequisite: Consent of instructor.

416. **Advanced Topics in Abstract Algebra.** 1 unit. Prerequisite: Consent of instructor.

420. **Projective Geometry.** 1 unit. Prerequisite: Mathematics 328.

422. **Algebraic Geometry.** 1 unit. Prerequisite: Mathematics 328.

423. **Differential Geometry.** 1 unit. Prerequisite: Mathematics 343.

424. **Riemannian Geometry.** Local and global properties of Riemannian manifolds. 1 unit. Prerequisite: Mathematics 423.

425. **Differentiable Manifolds, I.** Foundations of modern differential geometry, including multilinear algebra, exterior calculus, Stokes' theorem, Frebenius' theorem, affine connections, elements of Riemannian geometry and Lie groups, sheaves, cohomology of manifolds, the DeRham theorem, differentiable fiber bundles, the holonomy theorem, the Hodge theorem, elements of complex analytic manifolds. 1 unit. Prerequisite: Mathematics 318 and 332.

426. **Differentiable Manifolds, II.** See Mathematics 425 for description. 1 unit. Prerequisite: Mathematics 425.

428. **Topics in Geometry.** 1 unit. Prerequisite: Consent of instructor.

430. **Elementary Geometry from a Modern Viewpoint.** Designed for secondary school teachers of mathematics. Primary purpose of the course is to discuss critically the logical structure and content of Euclidean geometry from the modern point of view. Consideration is given to the historical development of the modern approach. 1 unit. Prerequisite: One year of experience in the teaching of high school mathematics; consent of instructor.

431. **Algebraic Topology, I.** Continuation of Mathematics 333. Categories and functors, homotopy groups, singular homology, Kunneth theorem, products in cohomology. 1 unit. Prerequisite: Mathematics 333.

432. **Algebraic Topology, II.** Continuation of Mathematics 431. CW-complexes, Cech homology, duality, spectral sequences, and other topics. 1 unit. Prerequisite: Mathematics 431.

433. **Fibre Spaces.** 1 unit. Prerequisite: Consent of instructor.

434. **Combinatorial and Differential Topology.** 1 unit. Prerequisite: Consent of instructor.

435. **General Topology.** Separation; global and local compactness and connectedness; compactification and completion; function spaces; other topics. 1 unit. Prerequisite: Mathematics 332 or consent of instructor.

438. **Topics in Topology.** 1 unit. Prerequisite: Consent of instructor.

439. **Seminar in Topology.** 1 unit. Prerequisite: Consent of instructor.

440. **Theory of Functions of a Complex Variable, I.** Application of the elementary theory is made to the study of conformal mappings, Riemann surfaces, entire and meromorphic functions. 1 unit. Prerequisite: Mathematics 348 or consent of instructor.

441. **Real Analysis, I.** Lebesgue measure on the real line, integration and differentiation of real functions, elementary applications to harmonic analysis. 1 unit. Prerequisite: Mathematics 347 or equivalent.

442. **Real Analysis, II.** Metric spaces, introduction to functional analysis, integration on general measure spaces. 1 unit. Prerequisite: Mathematics 441.

443. **Ordinary Differential Equations.** Existence, uniqueness, and continuation of solutions; topics selected from: the theory of linear differential operators, Sturm-Liouville theory, stability theory, qualitative theory of differential equations. 1 unit. Prerequisite: Mathematics 347 and a first course in ordinary differential equations.

444. **Partial Differential Equations.** 1 unit. Prerequisite: Consent of instructor.

445. **Theory of Functions of a Complex Variable, II.** 1 unit. Prerequisite: Mathematics 332 and 440, or consent of instructor.

446. **Hilbert Space.** Geometrical properties of Hilbert spaces; linear operators; the spectral theory for self adjoint and related operators. 1 unit. Prerequisite: Mathematics 442.

447. **Banach Spaces.** Geometrical properties of Banach spaces; bounded linear operators; applications to analysis; linear topological spaces. 1 unit. Prerequisite: Mathematics 442.

448. **Harmonic Analysis.** Locally compact groups, Haar measure, Fourier analysis, and Tauberian theorems. 1 unit. Prerequisite: Mathematics 442.

449. **Normed Rings.** Properties of normed rings; representation as rings of continuous functions or rings of bounded operators; applications to spectral theory, harmonic analysis, etc. 1 unit. Prerequisite: Mathematics 318 and 446 or 477.

450. **Ordered Spaces.** A study of ordered topological vector spaces and vector lattices and positive operators. 1 unit. Prerequisite: Mathematics 442 and 447.

451. **Theory of Probability.** 1 unit. Prerequisite: Mathematics 442.

452. **Theory of Probability.** 1 unit. Prerequisite: Mathematics 451.

453. **Analytic Theory of Numbers.** 1 unit. Prerequisite: Mathematics 317 and 348.

454. **Analytic Theory of Numbers.** 1 unit. Prerequisite: Mathematics 453.

455. **Mathematical Methods of Physics.** 1 unit. Prerequisite: Mathematics 348.

456. **Mathematical Methods of Physics.** 1 unit. Prerequisite: Mathematics 455.

457. **Advanced Numerical Analysis.** Same as Computer Science 457. Ordinary differential equations: existence theory of Picard, one-step and multi-step methods, discretization error, convergence, stability, boundary value problems; integral equations. 1 unit. Prerequisite: Computer Science or Mathematics 387 or consent of instructor.

458. **Numerical Solution of Partial Differential Equations.** Same as Computer Science 458. The numerical solution of initial and boundary value problems for partial differential equations; topics include the approximation of differential operators by difference operators, the solution of large systems of linear equations by iterative methods, and discussion of convergence and numerical stability. 1 unit. Prerequisite: Mathematics 455 or consent of instructor.

459. **Topics in Hydrodynamics.** 1 unit. Prerequisite: Consent of instructor.

460. **Relativity and Cosmology.** Same as Astronomy and Physics 424. Elements of tensor calculus and Riemannian geometry; special relativity; Lorentz transformations, equivalence of mass and energy; general relativity and the gravitational

field of the sun; galaxies and cosmology. 1 unit. Prerequisite: Consent of instructor. McVittie.

461. Applied Stochastic Processes. Introduction to topics such as spectral analysis, filtering theory, and prediction theory of stationary processes; Markov chains and Markov processes. 1 unit. Prerequisite: Mathematics 346 and 347.

463. Information Theory. Same as Computer Science and Electrical Engineering 463. Mathematical models for information channels and sources; existence theorems for and construction of error-correcting codes. 1 unit. Prerequisite: Mathematics 361.

465. Topics in Automata Theory. Same as Computer Science and Electrical Engineering 465. 1 unit. Prerequisite: Computer Science, Mathematics, or Electrical Engineering 392, or consent of instructor.

468. Topics in Analysis. 1 unit. Prerequisite: Consent of instructor.

469. Seminar in Analysis. 1 unit. Prerequisite: Consent of instructor.

470. Statistical Decision Functions. Statistics from the point of view of decision-making; introduction to the theory of games; minimax and other decision functions; techniques for determining optimal decision functions; applications to nonsequential and sequential decision-making in practice. 1 unit. Prerequisite: Consent of instructor.

473. The Theory of Testing Hypotheses. Methods of constructing statistical tests which have optimum properties in small samples; the principles of invariance, unbiasedness and similarity; most stringent tests and minimax tests. 1 unit. Prerequisite: Consent of instructor.

474. The Theory of Estimation. Methods of constructing uniformly minimum variance unbiased estimates; minimax estimation; estimation by confidence sets. 1 unit. Prerequisite: Consent of instructor.

478. Topics in Statistics. 1 unit. Prerequisite: Consent of instructor.

487. Theory of Approximation. Same as Computer Science 487. General approximation theory in normed linear spaces with primary emphasis on functions defined on an interval, and periodic functions; existence and uniqueness theorems; characterization of Chebyshev approximants; degree of approximation; interpolation with emphasis on the quality of interpolants as approximants; use of approximations in computing. 1 unit. Prerequisite: Mathematics 318, 348, or consent of instructor.

488. Topics in Applied Mathematics. 1 unit. Prerequisite: Consent of instructor.

489. Seminar in Applied Mathematics. 1 unit. Prerequisite: Consent of instructor.

490. Reading Course. 1 to 2 units. Prerequisite: Consent of instructor.

493. Proseminar. An introduction to the methods and tools of mathematical research. The work of the course consists in the solution by the students of assigned problems in various fields of mathematics and the presentation of these solutions in both written and oral form. 1 unit. Prerequisite: Mathematics 347; credit or registration in Mathematics 348.

499. Thesis Research. 0 to 4 units. Prerequisite: Consent of instructor. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Theory of Sets and the Real Number System. This course deals with elementary naive set theory and the development of the integers, the rational numbers, and the real numbers; principal emphasis is upon the mathematical needs of the

secondary teacher. 1 unit. Prerequisite: One year of calculus or consent of instructor.

301. **Fundamental Concepts of Algebra.** 1 unit. Prerequisite: One year of calculus or consent of instructor.

302. **Topics in Geometry.** Historical development of geometry, including tacit assumptions made by Euclid, Euclid's Fifth Postulate and its equivalents, and the discovery of non-Euclidean geometries; geometry as a mathematical structure; finite geometries; geometry as a study of invariants of set transformations; projective geometry; applications of group theory to geometry; vector geometry. 1 unit. Prerequisite: One year of calculus or consent of instructor.

303. **Advanced Aspects of Euclidean Geometry.** Selected topics from geometry as for example, circumcircle, nine-point circle, theorem on centroid and orthocenter, the construction of regular figures, isometries in the plane and space, rotations and translations, fixed points, ordered and affine geometries, geometry of inversive plane. 1 unit. Prerequisite: One year of calculus or consent of instructor.

305. **Teachers' Course.** A study of some special teaching problems in arithmetic, algebra, geometry, and trigonometry. Teaching procedures for important topics in these subjects are discussed in relation to their foundations in mathematics and logic. Topics suitable for presentation for superior high school students are also considered. ½ or 1 unit. Prerequisite: One year of calculus or consent of instructor.

306. **Selected Mathematical Topics for Secondary School Teachers, I.** This course deals with the teaching of the following topics in secondary school mathematics: symbolism and numbers; directed numbers; variables; equations (linear, quadratic, systems); sets; graphs; bases of enumeration; functions; critical examination of these topics. ½ or 1 unit. Prerequisite: One year of secondary school teaching in mathematics or consent of instructor.

307. **Selected Mathematical Topics for Secondary School Teachers, II.** This course deals with the teaching of the following topics in high school mathematics: variables in geometry; logic analysis of geometrical propositions; equivalence relations in geometry including congruence and similarity; geometry in the coordinate plane; cosine and sine as real valued functions of real arguments; a comparison of these functions with those ordinarily taught in the high school; symmetry; periodicity; evenness and oddness; exponential and logarithmic functions. ½ or 1 unit. Prerequisite: One year of secondary school teaching in mathematics or consent of instructor.

311. **Advanced Algebra.** For students interested in actuarial science, statistics, or teacher training in mathematics. 1 unit. Prerequisite: One year of calculus or consent of instructor.

312. **Advanced Algebra.** For students interested in actuarial science, statistics, or teacher training in mathematics. 1 unit. Prerequisite: One year of calculus or consent of instructor.

314. **Introduction to Set Theory and Mathematical Logic.** In general, this course supplies the set-theoretic and logical preliminaries for graduate work in mathematics. Contents: sets, relations, and mappings; the notions of constant and variable; the integers; cardinal and ordinal numbers; Zorn's Lemma; the real numbers; informal account of the propositional calculus and first order functional calculus; informal account of various axiomatic theories. 1 unit. Prerequisite: One year of calculus.

315. **Linear Transformations and Matrices.** 1 unit. Prerequisite: One year of calculus.

317. **Introduction to Higher Algebra.** 1 unit. Prerequisite: One year of calculus.

318. **Introduction to Higher Algebra.** 1 unit. Prerequisite: Mathematics 317.

327. **Introduction to Higher Geometry.** 1 unit. Prerequisite: One year of calculus.

328. **Introduction to Higher Geometry.** 1 unit. Prerequisite: Mathematics 327.

332. **Introduction to Set Theory and Topology.** Informal set theory, cardinals, ordinals, Zorn's Lemma, axiom of choice, topology of metric spaces, introduction to general topological spaces, and other topics. 1 unit. Prerequisite: Credit or registration in Mathematics 347.

333. **Introduction to Algebraic Topology.** Fundamental group, complexes, homology, simplicial approximation, structure of Abelian groups, exact sequences, axioms for homology. 1 unit. Prerequisite: Mathematics 318, 332, or consent of instructor.

341. **Differential Equations.** 1 unit. Prerequisite: One year of calculus.

342. **Differential Equations.** 1 unit. Prerequisite: Mathematics 341.

343. **Advanced Calculus.** 1 unit. Prerequisite: One year of calculus.

345. **Differential Equations and Orthogonal Functions.** 1 unit. Credit is not given for both Mathematics 345 and 349. Prerequisite: One year of calculus.

346. **Complex Variables and Applications.** For students who desire a working knowledge of complex variables. Covers the standard topics and in addition gives an introduction to integration by residues, the argument principle, conformal maps, Laplace transforms, and potential fields. Students desiring a systematic development of the foundations of the subject should take Mathematics 348. Credit is not given for both Mathematics 346 and 348. 1 unit. Prerequisite: Mathematics 343 or consent of instructor.

347. **Introduction to Higher Analysis: Real Variables.** 1 unit. Prerequisite: Mathematics 343 or consent of instructor.

348. **Introduction to Higher Analysis: Complex Variables.** 1 unit. Credit is not given for both Mathematics 346 and 348. Prerequisite: Mathematics 347.

349. **Differential Equations and Orthogonal Functions.** An honors course for students with superior mathematical ability. Credit is not given for both Mathematics 349 and 345. 1 unit. Prerequisite: Grade of B or higher in Mathematics 347; and, for undergraduates, registration in Mathematics 249.

350. **Topics in Pure Mathematics.** This is a survey course in pure mathematics for secondary school mathematics teachers. It deals with topics in number theory, topology, and analysis. 1 unit. Prerequisite: Consent of instructor.

351. **Topics in Applied Mathematics.** This is a survey course in applied mathematics for secondary school mathematics teachers. It deals with topics in the application of matrices to physical and social sciences, applications of Boolean algebra, game theory. 1 unit. Prerequisite: Consent of instructor.

353. **Elementary Theory of Numbers.** 1 unit. Prerequisite: One year of calculus.

354. **Elementary Theory of Numbers.** 1 unit. Prerequisite: Mathematics 317 or 353.

357. **Mathematical Models in the Social Sciences.** Uses many models drawn from the social sciences to motivate, illustrate, and give a unified development of topics in the following areas: linear algebra, graph theory, Markov chains, and linear and nonlinear systems of difference equations. 1 unit. Prerequisite: Mathematics 134 or equivalent.

361. **Theory of Probability.** 1 unit. Prerequisite: One year of calculus.

362. **Finite Differences.** 1 unit. Prerequisite: One year of calculus.

363. **Advanced Statistics.** 1 unit. Prerequisite: One year of calculus.

364. **Advanced Statistics.** 1 unit. Prerequisite: Mathematics 363.

366. **Theory of Probability.** Continuation of Mathematics 361. Topics covered may include random walks, Markov chains, branching processes, birth and death processes, and theory of queues. 1 unit. Prerequisite: Mathematics 361 or 363.

371. **Actuarial Theory.** 1 unit. Prerequisite: One year of calculus. PETERS.

372. **Actuarial Theory.** 1 unit. Prerequisite: Mathematics 371.

381. **Vector and Tensor Analysis.** 1 unit. Prerequisite: Mathematics 343 or equivalent, or consent of instructor.

382. **Vector, Tensor, and Matrix Methods in Applied Mathematics.** 1 unit. Prerequisite: Mathematics 381 or consent of instructor.

386. **Laplace Transforms.** 1 unit. Prerequisite: Mathematics 343.

387. **Introduction to Numerical Analysis.** Same as Computer Science 387. The main topics discussed in this course are error analysis and algorithms for the solution of equations, the computation of eigenvalues and eigenvectors, and numerical approximation of functions. 1 unit. Prerequisite: Computer Science 101; calculus and a knowledge of elementary matrix algebra, or consent of instructor.

388. **Mathematical Methods in Engineering and Science.** 1 unit. Prerequisite: Mathematics 343.

391. **Boolean Algebra and Switching Theory.** Same as Computer Science and Electrical Engineering 391. Boolean algebra with applications to sets, logic, electronic and relay combinational circuits: Karnaugh and Quine-McCluskey minimization procedures with applications; introduction to sequential circuits. ½ or 1 unit. Prerequisite: Consent of instructor.

392. **Introduction to Automata Theory.** Same as Computer Science and Electrical Engineering 392. Semigroups, partially ordered sets, and other algebraic systems; asynchronous machines; abstract synchronous machines and their properties; regular sets; decomposition theory. ½ or 1 unit. Prerequisite: Computer Science, Mathematics, or Electrical Engineering 391, or consent of instructor.

MATHEMATICS (APPLIED)

A wide variety of courses in applied mathematics, covering among others the fields of mechanics of particles and of rigid bodies, the mechanics of continuous media, electromagnetic theory and mathematical methods, is offered by various graduate departments in the sciences and engineering. A graduate student interested in applied mathematics should register as a major in the department of his choice. In consultation with his adviser he should plan a basic course of study which will serve as preparation for subsequent specialization and research in the theoretical aspects of one or more of the following fields: aerodynamics and hydrodynamics, astronomy, elasticity and plasticity, electrical theory, mathematics, mathematical meteorology, or the mathematical problems related to digital computer use and design.

MECHANICAL AND INDUSTRIAL ENGINEERING

The Department of Mechanical and Industrial Engineering offers work leading to the Master of Science and Doctor of Philosophy. Advanced study and professional training are offered in the general fields of power, design, production, and industrial engineering.

The prerequisite for graduate work in mechanical engineering is the equivalent of the undergraduate course requirements of the Bachelor of Science in mechanical engineering at the University of Illinois, with a grade-point average of at least 4.0.

The applications of those with grade-point averages below 4.0 but above 3.6 are individually reviewed by the graduate committee and admission is granted if credentials are satisfactory. Students who have obtained graduate credit in some other university may apply for admission provided their undergraduate records meet the above requirements and their grade-point averages in graduate work are at least 4.0.

A minimum of eight units must be completed for the master's degree when a thesis is included. The requirement of a master's thesis may be waived, but a minimum of nine units is then required.

For further information see *Notes on Graduate Study*, available from the Department of Mechanical and Industrial Engineering, 144 Mechanical Engineering Building. Correspondence concerning graduate studies should be addressed to the departmental chairman of the graduate committee, Professor Seichi Konzo.

GRADUATE FACULTY

Professors: H. H. Korst (Head of Department), H. D. Bareither, E. L. Broghamer, B. T. Chao, W. L. Chow, L. E. Doyle, G. W. Harper, W. S. Harris, E. F. Hebrank, J. A. Henry, W. L. Hull, S. Konzo, J. L. Leach, R. J. Martin, J. C. Miles, L. C. Pigage, E. I. Radzimovsky, F. Seyfarth, S. L. Soo, W. F. Stoecker, K. J. Trigger.

Associate Professors: R. W. Adkins, W. E. Bair, J. W. Bayne, J. C. Chato, R. G. Hering, B. A. Hertig, D. H. Offner, L. D. Savage, Jr., R. P. Strout, B. F. von Turkovich.

Assistant Professors: A. L. Addy, A. M. Clausing, B. G. Jones, C. S. Larson, F. A. Morrison, R. A. White.

Mechanical Engineering

COURSES FOR GRADUATES

401. **Thermodynamics and Transport Properties.** Thermodynamic and microscopic considerations for the prediction of properties. Caratheodory principle; relations between properties; microscopic description based on classical statistics; statistical equilibrium and trend toward equilibrium fluctuations; thermodynamics and transport properties; implication of wave mechanics. 1 unit. Prerequisite: Mechanical Engineering 301 or consent of instructor. Soo.

402. **Irreversible Thermodynamics.** Statistical considerations based on wave mechanics; gases and relativistic modifications; radiation and high temperatures; solids and liquids, systems at low temperatures; reactive systems; electrical and magnetic properties; fluctuations and irreversible thermodynamics. 1 unit. Prerequisite: Mechanical Engineering 301 or equivalent. Soo.

403. **Fundamentals of Combustion.** Same as Aeronautical and Astronautical Engineering 438. Fundamentals of kinetic theory, transport phenomena, chemical equilibria, and reaction kinetics; flames, their gross properties, structure, and gas dynamics including oscillatory and turbulent burning; solid and liquid propellant combustion; one dimensional detonation theory including structure and initiation; three-dimensional and other complex detonation waves; supersonic burning. 1 unit. Prerequisite: Mechanical Engineering 305 or Aeronautical and Astronautical Engineering 216.

404. **Gas Dynamics.** Introduction to theoretical gas dynamics; properties of compressible real fluids, fundamental laws and basic equations for subsonic and supersonic steady and nonsteady motion; interpretations and use in one- and multi-dimensional problems. 1 unit. Prerequisite: Differential equations, thermodynamics, fluid mechanics. Addy, Chow, Korst.

405. **Convective Heat Transfer.** Fundamentals of convective heat transfer; calculation of heat transfer within conductor and over submerged objects for laminar and turbulent flow; natural convection; film condensation and boiling; liquid metals. 1 unit. Prerequisite: Mechanical Engineering 306 or consent of instructro. CHAO, CLAUSING, HERING.

406. **Heat Conduction in Solids.** Fundamentals of heat conduction in isotropic and anisotropic solids; methods of solution to steady and transient heat conduction problems in one, two, and three dimensions; internal heat sources; periodic flow of heat; problems involving phase change; approximate analytical techniques. 1 unit. Prerequisite: Mechanical Engineering 306, Mathematics 346, or consent of instructor. CHAO, HERING.

407. **Selected Topics in Gas Dynamics.** Theoretical analysis of nonsteady processes including scavenging, pulse jet, shock tube, and complex compressor. Includes an introduction to high velocity laboratory techniques. 1 unit. Prerequisite: Mechanical Engineering 404. CHOW, KORST.

408. **Laboratory Investigation in Thermodynamics.** Special investigations involving thermodynamics analysis, thermodynamic properties, and performance of physical and chemical systems. ½ to 1½ units. Prerequisite: One-year course in thermodynamics; one half-year course in power laboratory. BAIR, MORRISON, SOO.

409. **Laboratory Investigations in Fluid Flow, Heat Transfer, and Combustion.** Special investigation in flow, metering, heat transfer, heat exchanger performance and design. ½ to 1½ units. Prerequisite: Courses in thermodynamics and fluid mechanics. ADDY, BAIR, CHAO, CHOW, CLAUSING, JONES, KORST, SAVAGE, WHITE.

410. **Thermal Radiation.** Fundamentals of radiant energy transport in absorbing and non-absorbing media; pyrometry; applications to selected problems involving combined energy transport mechanisms. 1 unit. Prerequisite: Mechanical Engineering 306 or consent of instructor. CHAO, HERING.

421. **Environmental Control.** Physiological reactions of humans to thermal and atmospheric environments, principles of ventilation, air-handling systems, free-stream jets and air distribution, illumination, sound, and acoustics. 1 unit. Prerequisite: Undergraduate courses in heat transfer and fluid mechanics. STOECKER.

423. **Air Conditioning and Refrigeration.** Load calculation, thermal system performance and optimization, static and dynamic control, industrial refrigeration absorption, thermoelectric, and cryogenic refrigeration. 1 unit. Prerequisite: Undergraduate courses in heat transfer and fluid mechanics. STOECKER.

428. **Laboratory Investigations in Refrigeration.** Special investigations in refrigeration. ½ to 1½ units. CHATO, STOECKER.

429. **Laboratory Investigation in Heating and Air Conditioning.** Special investigations in heating, ventilating, and air conditioning. ½ to 1½ units. Prerequisite: Two semesters of power laboratory or equivalent. CHATO, HARRIS, HERTIG, KONZO, STOECKER.

432. **Theory of Rotary Compressors.** Thermodynamical and mechanical fundamentals, compression with and without cooling, classification of compressors, similarity considerations and characteristics, principles of and computations for radial compressors, improvement in performance of integrating parts; axial flow compressors; lattice and airfoil theory; change in operating conditions of turbocompressors; regulation; rotary positive blowers. 1 unit. Prerequisite: Mechanical Engineering 205, 206, and 212; or Theoretical and Applied Mechanics 232; or Aeronautical and Astronautical Engineering 211. KORST.

438. **Laboratory Investigations in Power Machinery.** Special investigations in power machinery, such as turbines, engines, fans, and compressors. ½ to 1½ units. Prerequisite: One-year course in power laboratory. HEBRANK, HULL, STROUT.

441. **Machine Design.** A technical application course designed to focus the previously acquired design experience on the creative problem of developing machines to perform specified functions; proper considerations of manufacturing processes involved; checking of all parts for stress, wear, vibration, fatigue, etc. 1 unit. Prerequisite: Undergraduate course in dynamics of machines; one year of machine design. BROGHAMER.

442. **Linkage Synthesis.** Geometry of constrained motion in two and three dimensions; application of mathematical and other techniques to the synthesis of mechanisms. 1 unit. Prerequisite: Mechanical Engineering 342 or consent of instructor. BROGHAMER.

443. **Dynamics of Machinery.** Complementary to the undergraduate course and devoted to a more detailed study of velocities, accelerations, and forces in machine parts having reciprocating, rotating, and combined motions; balancing, flywheels; special topics. 1 unit. Prerequisite: Undergraduate course in dynamics of machines; one year of machine design. BROGHAMER.

445. **Design of Internal Combustion Engines.** Detailed study of the design of the internal combustion engine; gas-pressure and inertia-force diagrams; determination of bearing loads; torsional vibration analysis; stress determinations and design of important parts, including piston, connecting rod, crankshaft, flywheel, valve mechanism, and cam layout. 1 unit. Prerequisite: Undergraduate courses in dynamics of machines and in internal combustion engines; one year of machine design. HULL.

448. **Laboratory Investigations in Machine Design.** Special investigations in machine design. ½ to 1½ units. ADKINS, BROGHAMER, LARSON, OFFNER, RADZIMOVSKY.

451. **Theory of Metal Cutting.** A study of the theoretical factors involved in metal cutting and forming; basic mechanics of chip formation, friction, surface damage and finish; temperatures and temperature distribution during cutting; wear and tool-work compatability. Analysis of experimental data; critical review of pertinent literature and special topic assignments. 1 unit. Prerequisite: Undergraduate course in principles of metal cutting and heat treatment of metals or physical metallurgy. TRIGGER.

452. **Deformation and Mechanical Processing of Metals.** Theoretical and experimental aspects of deformation and mechanical processing of metals. Plastic deformation; fracture and fatigue; impact stresses and stress waves in metals; thermal and residual stresses; plastic forming of metals and its influence on the properties. 1 unit. Prerequisite: Mechanical Engineering 451; Metallurgical Engineering 408. TRIGGER.

458. **Laboratory Investigations in Production.** Special investigations in field of production, particularly in materials processing, metal cutting, and production engineering. ½ to 1½ units. TRIGGER, VON TURKOVICH.

493. **Seminar.** Presentation and discussion of significant developments in mechanical engineering. No credit. KONZO.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Thermodynamics.** Basic considerations of the three laws of thermodynamics; elementary statistical principles for the prediction of properties of pure substances and mixtures; transport properties; electric and magnetic systems. ¾ or 1 unit.

Prerequisite: Mechanical Engineering 206 or equivalent; consent of instructor. Soo.

302. **Nuclear Power Engineering.** Principles of release and exploitation of nuclear energy; uranium fission and the controlled chain reaction, reactor types and design principles; radiation hazards and shielding, adaptation and economics. ¾ or 1 unit. Prerequisite: Consent of instructor. Jones.

304. **Direct Energy Conversion.** Direct conversion of chemical, nuclear, and solar energies into electricity by electrochemical, thermionic, thermoelectric, photoelectric, photochemical, ferroelectric, magnetohydrodynamic, and plasma systems. ¾ or 1 unit. Prerequisite: Mechanical Engineering 301 or consent of instructor; Mathematics 345. Soo.

305. **Thermodynamics of High-Velocity Flow.** The thermodynamics of gases during high-velocity flow within enclosed channels using Mach number as the fundamental variable; analyses of the basic flow equations, effects of friction and plane shock theory; application to thermodynamic cycles involving nozzles, diffusers, compressors, combustion, and turbines. ¾ or 1 unit. Prerequisite: Mechanical Engineering 206, or 211, or consent of instructor. Addy, Chow, White.

306. **Industrial Heat Transfer.** Theory and application of numerical, analogical, and experimental methods to selected heat transfer problems; application of principles of convection, condensation, and boiling heat transfer to design of heat exchange equipment. 1 unit. Prerequisite: Undergraduate courses in fluid mechanics and heat transfer. Clausing, Hering, Savage.

309. **Experimental Gas Dynamics.** Experimental investigation of problems in the field of compressible fluid flow within enclosed channels. 1 unit. Prerequisite: Mechanical Engineering 211, or 305, or consent of instructor. Addy, Chow White.

311. **Instrumentation and Measurements.** Same as Agricultural Engineering 311. Accuracy, precision, and statistical consideration of measurement data; dynamics of measurement; displacement, velocity, acceleration, force, torque, pressure, and temperature measurements; mechanical impedance; measurements on fluids; instrumentation systems. ¾ or 1 unit. Prerequisite: Senior standing in engineering or science. Strout.

312. **Theory of Controls.** Introduction to the theory of controls. Dynamical analysis of physical systems; steady-state operations; graphical and analytical methods of analysis; applications. ¾ or 1 unit. Prerequisite: Consent of instructor. von Turkovich.

314. **Lubrication.** The theoretical basis of lubrication; hydrodynamic bearing theory; properties of lubricants; methods of testing; lubrication methods and appliances; study of the lubrication requirements of machines of many kinds. ¾ or 1 unit. Prerequisite: Undergraduate courses in machine design and fluid mechanics. Adkins, Offner, Radzimovsky.

323. **Design of Thermal Systems.** Selection of components in fluid- and energy-processing systems to meet system performance requirements, computer-aided design, system simulation, optimization techniques, investment economics, and statistical combinations of operating conditions. ¾ or 1 unit. Prerequisite: Mechanical Engineering 206, 211, and 213.

332. **Theory of Internal Combustion Engines.** Analysis of reciprocating engine cycle including thermodynamics and combustion and taking into consideration effects of fuel-air mixture, variable specific heats, chemical equilibrium and dissociation, and heat losses; flow through manifolds and valves; factors affecting breathing and scavenging; supercharging; bearings, lubrication, and function; effects of variables on performance. ¾ or 1 unit. Prerequisite: Undergraduate course in internal combustion engines or consent of instructor. Hull.

341. **Engineering Analysis and Design.** Correlation of previously acquired design experience with the creative problems of synthesis and analysis that depend upon design judgment. ¾ or 1 unit. Prerequisite: Mechanical Engineering 271 or consent of instructor. BAYNE, BROGHAMER, WHISENAND.

342. **Kinematic Analysis and Synthesis.** Geometry of constrained motion; application of mathematical and other techniques to the kinematic analysis and synthesis of mechanisms. ¾ or 1 unit. Prerequisite: Undergraduate course in kinematics or consent of instructor. BROGHAMER.

343. **Dynamics of Machinery.** A course complementary to the undergraduate course with emphasis on the analytical approach to the study of dynamic forces in machines, balancing, critical speeds, shaft vibrations, governors, and gyroscopes. ¾ or 1 unit. Prerequisite: Mechanical Engineering 221 or consent of instructor.

388. **Machine Tool Systems Analysis.** A study of the components, their analysis and synthesis in machine tool systems; power components, precision motion, dynamic response of machine skeleton, linear and nonlinear conditions, control elements, and computer control of machines. ¾ or 1 unit. Prerequisite: Mechanical Engineering 186, 271, or consent of instructor. VON TURKOVICH.

Industrial Engineering

COURSES FOR GRADUATES

401. **Scientific Managment, I.** Same as Industrial Administration 401. A study of modern management principles on the basis of quantitative methods, concentrating on such operation research techniques as nonlinear and dynamic programming and queueing theory. 1 unit. Prerequisite: Industrial Engineering 386 and Mathematics 361, or consent of instructor.

402. **Scientific Management, II.** Same as Industrial Administration 402. A systems approach to industrial problems involving inventory control, scheduling and line balancing, maintenance and investment theory; application of formally accumulated knowledge of operation research techniques. Problems from industry are assigned to small teams of students. 1 unit. Prerequisite: Industrial Administration or Industrial Engineering 401; background in computer technology or consent of instructor.

416. **Design of Construction and Industrial Operation, I.** Same as Civil Engineering 416. Conceptual development of a systems design procedure for optimal design of construction and industrial operations; general forms required for critical path networks, linear programs, theory of queues and inventory models required for systems design; design evaluation and control models. 1 unit. Prerequisite: Bachelor of Science in civil or industrial engineering; credit or registration in Mathematics 363; or consent of instructor.

417. **Design of Construction and Industrial Operations, II.** Same as Civil Engineering 417. Continuation of Industrial Engineering 416. 1 unit. Prerequisite: Industrial Engineering or Civil Engineering 416; credit or registration in Mathematics 315; or consent of instructor.

453. **Work Measurement.** A study of special problems of line balance, interference, and automation work loads as required to establish work standards (or production standards). 1 unit. Prerequisite: Industrial Engineering 332. PIGAGE.

454. **Production Engineering.** Advanced consideration of production engineering principles as related to cost analysis and reduction, control of flow of work in manufacture, evaluation of performance against standard, and compensation. Special investigations. 1 unit. Prerequisite: Industrial Engineering 453. PIGAGE.

458. **Laboratory Investigations in Industrial Engineering.** Special investigations of such problems as optimization of operations, programming systems, work standards, plant layout, and flow of materials. ½ to 1½ units. STAFF.

473. **Ergonomics Seminar.** Same as Physiology 473. Topics in ergonomics are explored in depth, such as effects of vibration on human performance, biomechanics of the hand, and functional dimension. ½ unit. Prerequisite: Industrial Engineering 305 or consent of instructor.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

304. **Principles of Ergonomics.** Same as Physiology 304. Concepts and design criteria to achieve optimum mutual adjustment of man and his work. Topics such as static and dynamic forces on the human frame, response to environmental stress (heat, vibration, noise), vigilance and fatigue, and man-machine systems are considered. 1 unit. Prerequisite: Consent of instructor.

305. **Quantitative Methods in Ergonomics.** Same as Physiology 305. Laboratory problems and discussion on measurements of the physical and mental capacities and limitations of human beings in relationship to the stresses and demands of working environment. Students become familiar with techniques and tools such as assessment of human energy expenditures on an industrial job, use of seating research chair; high speed and time lapse photography. Student teams select about six problems from a list of topics, or they may develop problems of special interest to the team. 1 unit. Prerequisite: Physiology or Industrial Engineering 304.

332. **Standard Time Systems.** The study of development, uses, and limitations of standard time data and predetermined time system. ¾ or 1 unit. Prerequisite: Industrial Engineering 232. PIGAGE.

333. **Engineering Applications of Statistics.** Applications of statistics to engineering problems; the calculated risk in making decisions on observed data; treatment of means, percentage, and variability; control charts, acceptance sampling, linear regressions, correlation, elementary experimental design. Use of desk calculators. ¾ or 1 unit. Prerequisite: Mathematics 263 or 363. HENRY.

334. **Introduction to Reliability Engineering.** Same as General Engineering 334. An introduction to concepts in engineering design, testing, and management for highly reliable components and systems. ¾ or 1 unit. Prerequisite: Industrial Engineering 333, or Mathematics 361, or equivalent with consent of instructor. HENRY.

350. **Manufacturing Process and Tool Design.** A study of and exercises in the design of manufacturing processes and tools for maximum efficiency; the utilization of computer techniques in design of manufacturing processes and tools. ¾ or 1 unit. Prerequisite: Industrial Engineering 282 or a course in engineering economy. DOYLE.

355. **Numerical Control of Manufacturing Processes.** A study of numerical control systems, manufacturing processes, principles and practices basic to numerical control, and programming methodology for numerical control. ¾ or 1 unit. Prerequisite: Mechanical Engineering 186 or consent of instructor; background in computer technology. DOYLE.

357. **Safety Engineering.** The study of engineering principles applied to industrial accident prevention; safe plant layout, safety in maintenance, boilers and pressure vessels, design and application of machine guards, material handling and storage, hand and power tools, welding hazards, electrical hazards, flammable liquids and fire protection, industrial health engineering and toxic materials. ¾ or 1 unit. Prerequisite: Consent of instructor. HARPER.

358. Problems in Safety Engineering. Extended and intensified study of specific safety problems; study of industrial safety procedures and methods of application. Designed to provide sound knowledge of accident prevention principles and applications for the student interested in entering the field of safety engineering in industry. ¾ or 1 unit. Prerequisite: Industrial Engineering 357; consent of instructor. HARPER.

359. Industrial Fire Protection. Technical study of fire protection based on engineering analysis; fire losses in industry, occupancy fire hazards, methods of fire prevention, fire detection equipment, control of fire, water supplies and extinguishment methods, hazardous materials, industrial fire brigades, and public fire departments. ¾ or 1 unit. Prerequisite: Credit or registration in Industrial Engineering 357 or consent of instructor. HARPER.

386. Industrial Engineering Analysis. Analysis and development of analytical techniques for the solution of problems in industrial engineering; application of statistical methods to uncertainty problems; analysis of linear programming techniques appropriate to the solution of allocation problems dealing with materials, money, men, and machines; queueing theories applied to maintenance and inventories. ¾ or 1 unit. Prerequisite: Mathematics 263, Industrial Engineering 286, or consent of instructor.

MICROBIOLOGY

See descriptions and course listings under Life Sciences, page 252.

MINING, METALLURGY, AND PETROLEUM ENGINEERING

The Department of Mining, Metallurgy, and Petroleum Engineering offers graduate work leading to the Master of Science and Doctor of Philosophy. The prerequisite for graduate work in metallurgical or mining engineering is the equivalent of the undergraduate courses in either of these majors which are required for the Bachelor of Science at the University of Illinois. For these major fields a Bachelor of Science in some related field may also be acceptable.

Those wishing to specialize in petroleum engineering or in the more general area of petrophysics should have a Bachelor of Science in engineering with advanced courses in mathematics, chemistry, physics, and/or geology.

A candidate for the Master of Science is required to have a minimum of eight units of graduate work, including a thesis. If a petition to waive the thesis requirement is granted, a minimum of nine units of graduate work is required. A thesis is required of candidates who hold research assistantships.

Students desiring to work for the Doctor of Philosophy are required to pass the departmental qualifying examination. This examination must be taken no later than the end of the first semester after receiving the Master of Science from this department, or not later than the end of the second semester in residence, if the student has a Master of Science from some other department or university.

The minor requirement of the Graduate College for the Doctor of Philosophy may be satisfied by taking courses in fields such as ceramics, chemistry, geology, mathematics, theoretical and applied mechanics, nuclear engineering, and physics.

GRADUATE FACULTY

Professors: C. A. WERT (Head of Department), P. A. BECK, H. K. BIRNBAUM, R. W. BOHL, W. H. BRUCKNER, A. J. DE WITTE, E. J. ECKEL, D. S.

Lieberman, M. Metzger, B. G. Ricketts, H. E. Risser, T. J. Rowland, A. E. Scheidegger, C. M. Wayman.

Associate Professors: C. J. Altstetter, D. Bond, J. Simon.

Mining Engineering

COURSES FOR GRADUATES

401. **Advanced Mineral Dressing and Coal Preparation.** Advanced theory and practice of mineral dressing and coal preparation processes. 1 unit.

402. **Mine Valuation, Taxation, and Mineral Economics.** A study of current methods of evaluating mine properties; methods of taxation of mine properties and mineral reserves; and the relation of mineral resources to economics of society. 1 unit.

405. **Advanced Mine Ventilation.** Study of physics of air, air conditioning for mines, mine ventilation systems, selection of fans for mines, ventilation surveys and instrumentation. 1 unit. Prerequisite: Consent of instructor.

406. **Design of Underground Openings.** Engineering problems in the design of underground openings; geologic structure and stress analysis in relation to underground openings. 1 unit. Prerequisite: Mining Engineering 356.

414. **Physical Chemistry of Clays and Soils.** Same as Agronomy and Ceramic Engineering 414. The application of physical chemical principles and concepts to surfaces and adsorption on surfaces. Silicate surfaces and water adsorption are emphasized. 1 unit. Prerequisite: Chemistry 340 and 341, or equivalent, or consent of instructor.

497. **Special Problems.** Individual studies in areas of mining or petroleum engineering, not covered by regular course offerings, carried out under the supervision of a member of the staff. 0 to 2 units. Prerequisite: Consent of instructor.

499. **Thesis Research.** Individual research in some phase of the general field of mining or petroleum engineering under the supervision of a member of the staff. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Mineral Processing.** Crushing, grinding, flotation, proximate analysis of coal, pumping of fluid-solid mixtures, quality control in ore dressing. ¾ unit.

302. **World Mineral Economics.** The role of minerals in a productive economy; the interdependence of minerals in industrial society and the problems arising out of their unequal geographic distribution and divided political control. ¾ or 1 unit.

351. **Geophysical Prospecting.** Same as Geology 351. Principles of geophysics and their application to mining processes. ¾ or 1 unit. Prerequisite: Consent of instructor.

353. **Sampling, Exploration, Valuation.** Theory of sampling applied to mineral deposits and concentrating plants; geological principles of exploration; surface and subsurface exploration; valuation. ¾ or 1 unit. Prerequisite: Geology 101 and 130; Mathematics 263.

356. **Rock Mechanics.** Mechanical properties of rocks; design of mine openings in bedded, massive, and fractured rock; methods of support; drilling; blasting. ¾ or 1 unit. Prerequisite: Mining Engineering 351.

360. **Analysis and Design of the Mining System.** Analyses of unit operation cycles

and production methods; design of materials handling systems and applications of operations research. 1 unit. Prerequisite: Mathematics 263; credit or registration in Mining Engineering 356.

393. **Special Problems.** Individual studies of any phase of mining or petroleum engineering selected by the student and approved by his adviser and the staff member who will supervise the study. 0 to 1 unit. Prerequisite: Consent of instructor.

Metallurgical Engineering

COURSES FOR GRADUATES

406. **Advanced Physics of Metals.** The free electron theory of metals; the zone theory of metals; magnetism and electrical conductivity. 1 unit. Prerequisite: Metallurgical Engineering 405, or Physics 385, or consent of instructor.

407. **Plastic Deformation and Annealing of Metals.** The mechanism and crystallography of plastic deformation of single crystals and of polycrystalline metals; annealing effects: recovery, subgrain growth and recrystallization; deformation textures and annealing textures. 1 unit. Prerequisite: Consent of instructor.

408. **Dislocations and Mechanical Properties of Metals.** General static and dynamic properties of single dislocations in crystals; dislocation interactions; properties of dislocation arrays; role of dislocations in metallurgical phenomena with particular emphasis on mechanical properties. 1 unit. Prerequisite: Consent of instructor.

409. **Crystal Physics.** The anisotropic properties of crystals treated by tensor and matrix methods with applications to paramagnetism, conduction and diffusion, thermoelectricity, deformation, elasticity, and martensitic transformations. The effects of crystal symmetry and the properties of aggregates are discussed. 1 unit. Prerequisite: Vector algebra, determinants, and thermodynamics; consent of instructor.

410. **Advanced X-Ray Metallography.** X-ray diffraction as applied to the study of metals and alloys; effects of cold work, annealing, substructures, preferred orientation and ordering, principles of electron and neutron diffraction. 1 unit. Prerequisite: Chemistry 427 or consent of instructor.

420. **Metallurgical Thermodynamics.** Fundamental thermodynamic considerations and applications of thermodynamics to metallurgical problems; particular emphasis on heterogeneous equilibrium and thermodynamic properties of solutions; topics approached from the viewpoints of both macroscopic thermodynamics and statistical mechanics. 1 unit. Prerequisite: Metallurgical Engineering 314 or equivalent.

421. **Kinetics of Phase Changes in Metals.** The viewpoint of statistical thermodynamics, rate theory, diffusion in solids, interface energy, nucleation theories, phenomenological analysis of nucleation and growth; application to crystal growth, diffusionless phase changes, oxidation, pearlite reaction, precipitation, sintering. 1 unit. Prerequisite: Metallurgical Engineering 420 or consent of instructor.

485. **Metallurgical Engineering Problems.** Individual study in areas of metallurgical engineering not covered by regular course offerings, carried out under the supervision of a member of the staff. ½ to 2 units. Prerequisite: Consent of instructor.

486. **Laboratory Investigations in Metallurgy.** Special investigations in metallurgy to provide an opportunity to employ some advanced experimental methods of research. Available only to non-thesis students enrolled in a Master of Science program. ¼ or ½ unit. Prerequisite: Consent of instructor.

493. **Seminar in Anelasticity.** Lectures and discussions of the nature of anelasticity and its application to metallurgy. 0 or ¼ unit. Prerequisite: Consent of instructor.

494. **Seminar on Phase Transformations in Metals.** Discussion of current research in this field including presentation by graduate students of their own work. 0 or ¼ unit. Prerequisite: Consent of instructor.

495. **Seminar on Diffusion and Imperfections.** Lectures and discussions on diffusion and imperfections in crystalline solids. 0 or ¼ unit. Prerequisite: Consent of instructor.

497. **Seminar on Alloy Phases.** Discussion and lectures on current research, including work by the graduate students, relating to the electronic structure and crystal structure of alloy phases. 0 or ¼ unit. Prerequisite: Consent of instructor.

498. **Colloquium in Physical Metallurgy.** Review of current metallurgical research in other laboratories by visting lecturers. Some of the research currently done in the department is also reviewed. Required of all graduate students in metallurgical engineering. No credit.

499. **Thesis Research.** Individual research in specialized problems under the supervision of members of the staff. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Metallurgy of Welding.** Heat flow and thermal cycles in welding and cutting of metals; physical metallurgy and mechanical properties of weld metal and thermally altered base metal; joining methods in relation to composition, microstructure, and mechanical properties; specifications, economics, and service requirements. ¾ or 1 unit. Prerequisite: Metallurgical Engineering 208 or equivalent.

302. **Powder Metallurgy.** Production and testing of powdered metals; fabrication and application of metal shapes produced from powdered metals. ½ or ¾ unit. Prerequisite: Approval of department; registration in Metallurgical Engineering 304.

304. **Powder Metallurgy Laboratory.** Experiments involving the testing, briquetting, sintering, repressing of metal powders, and the testing of sintered compacts. ¼ unit. Prerequisite: Approval of department; registration in Metallurgical Engineering 302.

306. **Design of Engineering Alloys.** A study of the fundamental principles which determine the constitution, structure, treatment, and application of alloy steels and other special-purpose high-performance alloys. ¾ or 1 unit. Prerequisite: Metallurgical Engineering 208 and 311.

307. **Corrosion of Metals.** Electrochemistry, thermodynamics, and kinetics of corrosion; behavior of ferrous and nonferrous metals; corrosion rates; corrosion control, cathodic and anodic protection; high-temperature corrosion; corrosion testing; electrolytic machining methods. ¾ or 1 unit. Prerequisite: Mechanical Engineering 234 or equivalent.

310. **X-Ray Metallography.** X-ray generation and scattering with applications to problems in physical metallurgy, such as phase identification, the determination of solid solubility, the measurement of grain size and preferred orientation, and other topics. ¾ unit. Prerequisite: Physics 108.

311. **Advanced Phase Diagrams.** Interpretation of multicomponent phase diagrams for metal systems. ½ unit. Prerequisite: Metallurgical Engineering 201 or equivalent.

314. **Metallurgical Thermodynamics.** Thermodynamic principles are applied to the study of phase and chemical equilibrium and to the calculation of free energy of phases. ¾ unit. Prerequisite: Credit or registration in Chemistry 246.

315. **Metallurgical Kinetics.** Diffusion and heat flow calculations and their applications to kinetics of metallurgical processes. ¾ unit. Prerequisite: Metallurgical Engineering 208 and 314.

316. **Mechanical Metallurgy.** Fundamentals of plastic deformation of crystalline solids; elementary theory of statics and dynamics of dislocations; applications to deformation of single crystals and polycrystals; fracture; effect of metallurgical variables on mechanical properties. ¾ unit. Prerequisite: Consent of instructor.

318. **Physics of Metals.** The nature of the perfect and imperfect crystal, the electronic structure of solids, electrical conduction in metals and semiconductors, dielectric and magnetic properties of solids. ¾ unit. Prerequisite: Consent of instructor.

334. **Physical Metallurgy for Engineers.** Fundamentals of crystallography, imperfections, alloying, deformation. Consideration of composition temperature, and prior thermal and mechanical treatement in the use of metals, with emphasis on their mechanical properties. ¾ or 1 unit. Prerequisite: Credit or registration in Theoretical and Applied Mechanics 221 or Aeronautical and Astronautical Engineering 224, or consent of instructor.

384. **Properties of Solids.** Same as Electrical Engineering 384. Perfect and imperfect crystal lattices, electronic structure of solids including basic theory and applications to transport properties of metals and semi-conductors, semi-conductor diodes; dielectric and magnetic properties of solids. ¾ unit. Prerequisite: Physics 383.

Petroleum Engineering

COURSES FOR GRADUATES

420. **Porous Media Hydromechanics.** Introduction to theoretical hydromechanics. Classification of fluids, fundamental laws and basic equations of motion applicable to microscopic and macroscopic regimes; treatment of interfacial forces and surfaces in multi-phase flow as particularly applied to porous media systems. ¾ or 1 unit. Prerequisite: Mathematics 343, Petroleum Engineering 373, or consent of instructor.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

371. **Reservoir Mechanics, I.** The mechanics of the movement of fluids in the porous rock reservoirs of the subsurface, especially as related to questions dealing with the production and storage of petroleum fluids, ground water, and natural gases. 1 unit. Prerequisite: Mathematics 345; Theoretical and Applied Mechanics 235.

372. **Reservoir Mechanics, II.** A continuation of Petroleum Engineering 371, showing the application of the fundamental concepts in developing procedures for forecasting the future performance of reservoir systems as derived from a knowledge of initial and boundary conditions, and as derived with reference to the past history of fluid movement and displacement. 1 unit. Prerequisite: Petroleum Engineering 371.

373. **Advanced Reservoir Engineering.** Physical principles of oil production including the hydrodynamics of the recovery process with attention given to the valuation and practical economic aspects. ¾ or 1 unit. Prerequisite: Mathematics 345, Petroleum Engineering 372, or consent of instructor.

MUSIC

The School of Music offers the Master of Music, Doctor of Musical Arts, Doctor of Philosophy in Musicology, Master of Science in Music Education, Advanced Certificate in Music Education, and Doctor of Education with a major in Music Education. Inquiries concerning graduate work in music should be addressed to Duane A. Branigan, Director of the School of Music, 100 Smith Music Hall.

Master of Music. The major field may be in musicology, music theory and composition, or performance and literature (organ, voice, piano, violin, viola, cello, solo wind instruments, and percussion instruments).

The admission requirement, in terms of grade-point average, is at least 3.5. In addition, an applicant is required: (1) to have finished successfully a four-year undergraduate curriculum in music or music education, or its equivalent, at the University of Illinois or another accredited institution; and (2) to pass a qualifying examination in the major field of concentration. If the major is to be performance and literature, this examination is essentially one of performance on the major instrument. If an applicant is unable to appear before the graduate committee, recordings may be substituted. If the major is to be musicology, theory, or composition, applicants must present to the committee writings or other evidence of their ability to pursue work on the graduate level. For the field of musicology, a reading knowledge of German or French is required. Candidates in voice should have had one year each of French, German, and Italian, unless two years of one language have been completed in high school. All prospective candidates for the Master of Music must take a placement examination in the history of music and the theory of music.

Doctor of Musical Arts. The fields of specialization for this degree are limited to those areas which can serve properly as a basis for the development of the comprehensive type of musicianship and scholarship the candidate is expected to exhibit. The degree programs comprise the following major areas: composition, choral music, piano, organ, violin, viola, cello, voice, and wind instruments.

In addition to meeting the general requirements for admission to the Graduate College, an applicant must obtain the recommendation of the graduate committee of the School of Music in order to be admitted to this program. The prerequisites for admission are as follows:

(1) The Master of Music with major field in one of the areas listed above, including work as follows (or its equivalent):

(a) Major in Composition: advanced composition, two units; theory, two units; Music 428, Problems and Methods, one unit; electives, three units.

(b) Major in Performance and Literature: performance and literature, two units; special literature, two units; Music 428, Problems and Methods, one unit; electives, three units.

(2) A high level of proficiency in composition or performance.

(3) Appropriate experience in ensemble playing and/or score reading.

(4) The successful completion of approximately thirty-two semester hours (or the demonstration of an equivalent background) in the liberal arts and sciences including a minimum of six hours in each of the following: general history, literature, psychology, and philosophy. Students lacking an appropriate background in liberal arts and sciences may be admitted provisionally, providing they satisfy the stated requirements before taking the preliminary examination.

(5) Successful completion of entrance examinations. These examinations in performance and literature, the history of music, and the theory of music must be taken immediately prior to the student's first registration. Prospective applicants should write to the School of Music, 100 Smith Music Hall, for complete information concerning the nature of these examinations.

If the candidate fails to pass the entrance examinations, he must repeat and pass all or parts of them no later than the end of the second semester in residence, or pass

deficiency courses with grades of at least B. Until the examinations or courses have been passed, the student is considered to have a provisional status.

After admission to the doctoral program, the student must fulfill all requirements of the Graduate College pertaining to residence, number of units of graduate work, examinations, grades, and major and minor fields. The language examinations may be selected from the following depending upon the thesis topic: German, French, Russian, Italian, Spanish, Portuguese, Arabic, and Japanese. The selection must have the approval of the doctoral committee.

A minimum of sixteen units of graduate credit beyond the eight units required for the Master of Music is necessary to earn the Doctor of Musical Arts. In the fields of composition, and performance and literature, three units are devoted to the completion of a special doctoral project: for the former, the writing of an original score on a large scale; for the latter, the study of a comprehensive repertory and either two solo recitals, or one solo recital and two of the following options: (1) a concerto performance; (2) the performance of a major role in an opera or oratorio; (3) a chamber music program; (4) a lecture recital; (5) a coaching performance of an instrumental or vocal ensemble. Two units are devoted to the completion of an original thesis. In the field of choral music, one unit is devoted to a doctoral project involving the preparation and presentation of a choral program of approximately one hour in length selected from a comprehensive repertory. Four units are devoted to the completion of an original thesis.

In addition to the above, work for the Doctor of Musical Arts includes the following required courses: composition or performance and literature, three units; Music 420, Seminar in Music Literature for Doctoral Candidates, two units. One unit of work must be taken in the field of education or music education unless the candidate has previously passed equivalent course work. At least two, but no more than four units, are normally devoted to an outside minor field. If, however, in the opinion of the graduate adviser, the candidate has acquired a strong background in general education, including history, philosophy, and literature, he may substitute an inside minor in such fields as musicology, ethnomusicology, theory, or composition. Candidates for the Ph.D. in Musicology may substitute ethnomusicology, theory, or composition.

Three of the six units of electives must be in music literature or theory.

Prior to the beginning of the doctoral project and the thesis, the student must complete the preliminary examination, which is administered by a committee appointed by the Dean of the Graduate College.

Doctor of Philosophy in Musicology. The Doctor of Philosophy in Musicology is intended for applicants whose interests lie in research in the history of music, theory of music, psychology of music, ethnomusicology, aesthetics, and the relation of music to social life and thought.

In addition to meeting the general requirements for admission to the Graduate College (see pages 19 to 24), an applicant must obtain the recommendation of the graduate committee of the School of Music in order to be admitted to this program. Applicants must (1) have completed work equivalent to that required by the School of Music of candidates for the Master of Music with a major in musicology or theory of music; (2) have acquired a background of approximately thirty-two semester hours in the liberal arts and sciences, including general history, philosophy, and literature; (3) be adequately prepared to pursue the doctoral program as determined by examinations administered by the graduate committee of the School of Music.

After admission to the doctoral program in musicology, the student must fulfill all requirements of the Graduate College pertaining to residence, number of units of graduate work, thesis, examinations, calendar, grades, major and minor fields, and foreign languages.

Eight of the sixteen units must be in Music 499 and are devoted to the completion of an original doctoral thesis. Admission to candidacy is recommended only after successful completion of the following:

(1) Sixteen units of graduate credit, or the equivalent, in courses including Music 321, 322, 414, 415, and 423. At least twelve of the sixteen units offered for graduate credit must be in the field of music. No more than two of the sixteen units may be in performance.

(2) In addition to the general foreign language requirements, proficiency in Latin is required. An examination in one or more additional foreign languages may be required when, in the opinion of the graduate committee, such ability is necessary for proper research in the student's field of concentration.

(3) A preliminary examination administered by a committee appointed by the Dean of the Graduate College.

Master of Science in Music Education. Candidates for this degree must earn four units in music, two units in education, and two units in electives. Requirements are four units of music; two courses from History and Philosophy of Education 301, 302, 303, 304, one unit; Educational Psychology 311 and 312, one unit; and electives, two units. The electives may be in music, in education, or, in exceptional cases, in other fields. The grade-point average required for admission is 3.5. All applicants for admission are required to satisfy placement examinations in music history, music theory, and performance and literature in the principal music area prior to the initial registration. See pages 45 and 46.

Advanced Certificate in Music Education. The program leading to the Advanced Certificate in Music Education consists of a minimum of one year of work beyond the master's degree. The program is designed to provide advanced professional preparation for music educators. It is a terminal program and students who become candidates for the certificate are not considered as beginning work leading to the Doctor of Education with a major in music education.

Admission. A candidate for admission must hold a master's degree in music or music education from an accredited institution and must have completed satisfactorily at least two years of professional employment in music education.

At the first registration, placement examinations are administered in music history, music theory, and applied music.

Residence. At least four units must be earned in residence on the Urbana campus. This requirement may be met by spending one full semester or two eight-week summer sessions in residence.

Program. A minimum of eight units beyond the master's degree is required. Music 440 and 441 and either Educational Psychology 411 or 412 are required. The remainder of the program is based upon the student's needs and interest and upon the deficiencies revealed in placement tests. No more than one unit of performance and literature may be counted toward the certificate.

Students who, at the time of first registration, do not hold a valid teaching certificate in music from the state in which they are employed are required to take courses sufficient to meet the certification requirements.

Doctor of Education. The program leading to the Doctor of Education with a major in Music Education is designed to provide advanced professional preparation for music educators and to develop educational leaders with a high level of musical, professional, and intellectual competence. The program is offered jointly by the School of Music and the College of Education.

Admission. A candidate for admission must hold a master's degree with a major in music education or the equivalent from an accredited institution. Admission is determined by examinations administered by the School of Music and the College of Education, personal interviews, record of previous education and experience, and recommendation from persons who have known the candidate. Examinations are administered by the School of Music in music education, music theory, music history, and applied music.

Applicants for admission should present credentials well in advance of their first registration. Admission is not complete until the candidate is accepted by two joint advisers, one from the School of Music and one from the College of Education.

Residence. Minimum residence requirements are two consecutive semesters during each of which a minimum of three units of work is successfully completed, or one semester during which a minimum of three units is successfully completed and the summer session immediately preceding or following during which a minimum of one and one-half units is successfully completed, plus an additional summer session during which a minimum of one and one-half units is successfully completed.

Program. At least sixteen units of work beyond the master's degree are required, including six units in music courses and six units in education courses. No more than two units of credit in applied music may be counted toward the degree.

The following courses are required: History and Philosophy of Education 410, Educational Psychology 415, Music 421, 440, and 441. The remainder of the program is planned for each candidate in terms of present and future professional needs and interests. For work completed elsewhere, see page 42. Extramural course work may not be included as part of this sixteen-unit requirement.

A thesis is required. It may be in the area of improving professional practice and may be a field study. No academic credit is granted for the thesis. General regulations of the Graduate College covering the filing of thesis title and the preparation, submission, and publication of theses must be met.

GRADUATE FACULTY

Professors: D. A. Branigan (Director of School of Music), B. Bergethon, G. W. Binkerd, Dorothy E. Bowen, Dorothy E. Clark, H. A. Decker, C. DeLaney, P. S. Farrell, S. Fletcher, B. R. Foote, L. T. Fredrickson, J. C. Garvey, S. Goldthwaite, B. M. Goodman, R. E. Gray, R. J. Hamilton, C. E. Hamm, L. A. Hiller, M. H. Hindsley, G. H. Hunter, B. Johnston, K. Kellogg, J. R. Kelly, Colleen J. Kirk, E. D. Kisinger, C. Leonhard, A. J. McDowell, B. Nettl, P. S. Pettinga, Claire L. Richards, A. L. Ringer, P. Rolland, H. C. Schmitt, H. O. Sexton, S. Stravinsky, R. H. Swenson, P. Ulanowsky, Grace E. Wilson, L. E. Zirner.

Associate Professors: J. L. Bailey, E. S. Berry, A. M. Carter, W. R. Coggins, R. J. Colwell, T. L. Holden, H. Karp, E. J. Krolick, S. Martirano, J. H. McKenzie, W. H. Miller, P. Painter, D. W. Sanders, R. B. Smith, R. E. Thomas.

Assistant Professors: G. H. Behague, Mary M. Burdette, R. B. MacDonald, Evelyn Reynolds, A. R. Thomas.

COURSES FOR GRADUATES

400. Advanced Instrumentation: Chamber and Symphonic. Orchestrate for chamber and symphony orchestras; works of classical, romantic, and modern composers. ½ or 1 unit. Prerequisite: Undergraduate instrumentation. Kelly.

401. Advanced Instrumentation: Band. Arrange for the concert band, works from orchestra, organ, and chamber music by composers of the classical, romantic, and modern periods. ½ or 1 unit. Prerequisite: Undergraduate instrumentation. Hindsley.

402. Analysis in Relation to Performance and Interpretation, I. A unifying course in the structure of music, in which analysis is related to the performance and understanding of music. Course material drawn from standard literature from the Renaissance to the present day with emphasis on the smaller forms. 1 unit. Prerequisite: Music 104 or equivalent; consent of instructor. Leonhard.

403. Analysis in Relation to Performance and Interpretation, II. A unifying course in the structure of music, in which analysis is related to the performance and understanding of music. Course material drawn from standard literature from the

Renaissance to the present day with emphasis on the larger forms. 1 unit. Prerequisite: Music 402. LEONHARD.

406. **Composition.** Advanced study of contrapuntal forms; study of contemporary melodic and harmonic practices; original work in advanced composition. ½ to 1½ units. COMPOSITION FACULTY.

410. **History of Music Theory.** 1 unit; maximum accumulated credit, 2 units. Prerequisite: Graduate standing in musicology or composition, or consent of instructor. HAMM.

411. **Introduction to Ethnomusicology.** A comprehensive survey of concepts, problems, and methods of research in non-Western and folk music. 1 unit. Prerequisite: Graduate standing in musicology or consent of instructor. NETTL.

412. **History of Musical Aesthetics, I.** A survey of the principal philosophies of music, their historical backgrounds, and their relation to musical styles. From Pythagoreanism to the humanistic period. ½ or 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Graduate standing in music. RINGER.

413. **History of Musical Aesthetics, II.** A survey of the principal philosophies of music, their historical backgrounds, and their relation to musical styles from the seventeenth century to the present day. ½ or 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Music 412. RINGER.

414. **Notation, I.** The history of notation from its beginning to 1400. ½ unit. Prerequisite: Consent of instructor. GOLDTHWAITE.

415. **Notation, II.** The history of notation from 1400 to 1600, including instrumental tablatures. ½ unit. Prerequisite: Music 414 or consent of instructor. GOLDTHWAITE.

416. **History of Instrumental Music to 1600.** A study of instrumental music from its beginnings in the Middle Ages to the end of the Renaissance. ½ or 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Music 312 or consent of instructor. HANSELL.

417. **History of Instrumental Music from 1600 to 1750.** A study of instrumental music in the Baroque era. ½ or 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Music 416 or consent of instructor. TEMPERLY.

418. **The Origins and the History of Opera up to Gluck.** The antecedents of opera in the sixteenth century; social, cultural, intellectual forces leading to its development; study of scores, librettos, scenography; readings on performance practices, theory, and aesthetics of opera. The principal composers covered are Monteverdi, Cavilli, Cesti, Lully, Rameau, Blow, Purcell, Scarlatti, Handel, Gluck. ½ or 1 unit. Prerequisite: Music 312 or consent of instructor. HAMM.

419. **The History of Opera from Mozart to the Present.** A detailed examination of stylistic and structural developments in opera after Gluck, with special reference to representative works from Mozart to Schoenberg viewed in relation to the general musical and cultural background of their time and place of origin. ½ or 1 unit. Prerequisite: Music 312 and 313, or consent of instructor. HAMM.

420. **Seminar in Music Literature.** Intensive study of outstanding works selected from all fields of music literature. Required of all students (except those in choral music) enrolled in the Doctor of Musical Arts program. 1 unit; maximum accumulated credit, 2 units. Prerequisite: Consent of instructor. GOLDTHWAITE.

421. **Seminar in Music Education.** An introduction to problems and methods of research in music education. Required of all candidates for the Doctor of Education in music education. 1 unit. Prerequisite: Graduate standing in music education or consent of instructor. BERGETHON.

422. **Seminar in Theory of Music.** Intensive study of selected topics in the fields of music theory, history of theory, and history of musical materials. ½ or 1 unit. Prerequisite: Grade standing in music theory or consent of instructor.

423. **Seminar in Musicology.** Problems in historical and systematic musicology; discussions of special problems and reports on individual research. 1 unit. Prerequisite: Graduate standing in musicology and Music 321, or consent of instructor. STAFF.

424. **Seminar in the Works of a Selected Composer.** A seminar devoted to intensive historical and analytical study of the works of important composers. Each semester is devoted to one composer, e.g., Bach, Beethoven, Handel, Haydn, Mozart, Wagner, etc. 1 unit; may be repeated for a maximum of 2 units. Prerequisite: Music 213 and 214; two of the following: Music 310, 311, 312, 313, 315, or equivalent. STAFF.

428. **Problems and Methods.** An introduction to methods in research and stylistic criticism and to bibliographic aids, editions and editing of music, as related to the work of the musician and composer. Reports of bibliographic problems and on individual projects are presented orally and in writing. Required of all students in the Master of Music program, except those majoring in musicology. 1 unit. BEHAGUE, TEMPERLY.

429. **Historical Studies in Twentieth-Century Music.** A seminar in contemporary music, with emphasis on the historical foundations of current trends in musical composition. ½ to 1 unit; maximum accumulated credit, 2 units. Prerequisite: Music 315, 422, or equivalent. HILLER.

430. **Advanced Orchestra Conducting and Literature.** Intensive study of conducting techniques and problems related to standard orchestral literature. Includes a survey of materials for school and community orchestra. 1 unit. Prerequisite: Previous conducting experience. GOODMAN.

431. **Advanced Band Conducting and Literature.** Study of problems and techniques of band conducting and a survey of literature for the concert band. 1 unit. Prerequisite: Bachelor's degree with major work or experience in band and/or orchestra; consent of instructor. HINDSLEY.

432. **Advanced Choral Techniques.** An intensive laboratory approach to the development of advanced techniques necessary for working effectively with choral ensembles. 1 unit. Prerequisite: Graduate standing in music. KIRK.

433. **Advanced Choral Literature and Conducting.** An intensive survey of choral literature with laboratory organization for reading, conducting, and interpretation of choral music of all periods, styles, and voice arrangements. 1 unit. Prerequisite: Graduate standing in music education, Music 432 or equivalent, or consent of instructor. DECKER, KIRK.

434. **Piano Literature.** 1 unit; maximum accumulated credit, 2 units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education, or consent of instructor.

435. **Vocal Literature.** Study of solo song in larger works, and solo art song. 1 unit; maximum accumulated credit, 2 units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education, or consent of instructor. KELLOGG.

436. **Organ Literature.** An intensive study of organ literature from Bach to the present. The material includes the music itself, recordings, and collateral readings. 1 unit; maximum accumulated credit, 2 units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education, or consent of instructor. PETTINGA.

437. **String Instrument Literature.** 1 unit; maximum accumulated credit, 2 units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education, or consent of instructor. FARRELL.

438. **Wind Instrument Literature.** An integrating course offering the opportunity to survey at the graduate level the field of solo and ensemble wind literature. The material includes analysis and performance, when possible, of the music itself, recordings, and collateral readings. 1 unit; maximum accumulated credit, 2 units. EDLEFSEN, KISINGER.

439. **Percussion Instruments Literature.** An integrating course offering the opportunity to survey and analyze the field of solo and ensemble percussion literature. The material includes analysis and performance, when possible, of the music itself, recordings, and collateral readings. 1 unit; maximum accumulated credit, 2 units. Prerequisite: Graduate standing in music; consent of instructor. MCKENZIE.

440. **Foundations and Principles of Music Education, I.** A consideration of the historical and philosophical foundations of music education; the application of the principles of education to the music program. Major emphasis is placed on current trends in educational thought and their implications for music education. ½ or 1 unit. Prerequisite: Graduate standing in music education; consent of instructor. LEONHARD.

441. **Foundations and Principles of Music Education, II.** A consideration of the psychological foundations of music education; the application of the principles of education to the music program. Major emphasis is placed on current trends in educational thought and their implications for instruction, supervision, administration, and evaluation in music education. ½ or 1 unit. Prerequisite: Graduate standing in music education; consent of instructor. LEONHARD.

442. **The General Music Program in Secondary Schools.** A detailed consideration of the general music program, its objectives, organization, and operation. Special attention is given to materials and methods of teaching. ½ or 1 unit. Prerequisite: Graduate standing in music education. LEONHARD.

443. **Administration and Supervision of Music Education.** Deals with the functions of supervisors and directors of music education in administering music programs in elementary and secondary schools. ½ or 1 unit. Prerequisite: Graduate standing in music or music education. BERGETHON.

444. **The General Music Program in Elementary Schools.** A detailed consideration of elementary general music, its objectives, organization, operation. Special attention is given to materials and methods of teaching. ½ unit. Prerequisite: Graduate standing in music education. BERGETHON.

445. **Music in Higher Education.** An orientation to the organization, teaching, and administration of music in the college and university. ½ or 1 unit. Prerequisite: Graduate standing in music or music education. BERGETHON.

446. **Seminar and Laboratory in Musical Acoustics, I.** Special topics in acoustics, including formant theory and communication theory; application of electrical and electronic techniques to music reproduction and propagation; audio-visual aids. ½ or 1 unit. Prerequisite: Graduate standing in music or music education, or consent of instructor. HILLER.

447. **Seminar and Laboratory in Musical Acoustics, II.** Techniques of modern experimental electronic music; related music theory; computational music and related topics. Individual projects for selected students. ½ or 1 unit. Prerequisite: Music 446 or consent of instructor. HILLER.

450. **History of Vocal Ensemble and Choral Music, I.** A critical and analytic study of vocal and choral ensemble music from the Middle Ages to 1750. 1 unit; S, ½ unit.

451. **History of Vocal Ensemble and Choral Music, II.** A critical and analytic study of vocal and choral ensemble music from 1750 to the present. 1 unit; S, ½ unit.

480. **Piano.** ½ or 1 unit. Prerequisite: Bachelor of Music; successful completion of a qualifying examination given by the graduate committee. GRADUATE FACULTY.

481. **Voice.** ½ or 1 unit. Prerequisite: Bachelor of Music; successful completion of a qualifying examination given by the graduate committee. GRADUATE FACULTY.

482. **Organ.** Selected studies from the masterworks of organ literature. ½ or 1 unit. Prerequisite: Bachelor of Music; successful completion of a qualifying examination given by the graduate committee. GRADUATE FACULTY.

483. **String Instruments.** ½ or 1 unit. Prerequisite: Bachelor of Music; successful completion of a qualifying examination given by the graduate committee. GRADUATE FACULTY.

484. **Wind Instruments.** ½ or 1 unit. Prerequisite: Bachelor of Music; successful completion of a qualifying examination given by the graduate committee. GRADUATE FACULTY.

485. **Percussion Instruments.** ½ or 1 unit. Prerequisite: Bachelor of Music; successful completion of a qualifying examination given by the graduate committee. GRADUATE FACULTY.

489. **Doctoral Projects.** Special projects for candidates for the Doctor of Musical Arts. Open only to students in the Doctor of Musical Arts program. 1 to 3 units. Prerequisite: Consent of instructor. GRADUATE FACULTY.

499. **Thesis Research.** Research in special projects. 0 to 4 units. Prerequisite: Consent of instructor. GRADUATE FACULTY.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Eighteenth-Century Counterpoint.** The study of the technique of contrapuntal writing as found in the works of J. S. Bach and other eighteenth-century composers. Imitation, canon, invertible counterpoint, two- and three-part inventions, etc., are studied through writing and analysis of compositions by eighteenth-century composers. ½ unit. Prerequisite: Music 104 and/or consent of instructor. BINKERD, FREDRICKSON, KELLY, MARTIRANO.

301. **Fugue.** The study of fugal writing during the eighteenth and early nineteenth centuries. A continuation of the study of tonal counterpoint begun in Music 300, with special emphasis on the study and analysis of the fugal works of J. S. Bach, Handel, and Beethoven and on the writing of fugues and part fugues. ½ unit. Prerequisite: Music 300 and/or consent of instructor. BINKERD, FREDRICKSON, KELLY, MARTIRANO.

302. **Musical Acoustics, I.** A survey of basic topics in the physics of music: wave motion and the physical properties of sound; the ear and hearing; timbre, formant theory, and the acoustical properties of musical instruments. ½ unit. Prerequisite: Consent of instructor. HILLER.

303. **Musical Acoustics, II.** Acoustics, mathematics, aesthetics of pitch organization in music; scales, tuning, and temperament; pitch and rhythm, and their structural interrelationships; theories of perception of pitch and rhythm. ½ unit. Prerequisite: Music 302 and/or consent of instructor. JOHNSTON.

304. **Analytical Techniques, I.** Examination of music from plain song and the earliest polyphony to the close of the sixteenth century. Emphasis is placed upon penetration of the compositional techniques used and includes the study of form and harmony as these bear on the problems. ½ unit. Prerequisite: Music 104 or consent of instructor.

306. **Composition.** Work in original composition including the small and large homophonic forms. ½ or 1 unit. Prerequisite: Music 104 or 106, or consent of instructor. COMPOSITION FACULTY.

307. **Counterpoint of the Fifteenth and Sixteenth Centuries.** Analysis and writing in the principal contrapuntal styles of the fifteenth and sixteenth centuries. ½ unit. Prerequisite: Consent of instructor. BINKERD.

308. **Analysis of Musical Form.** An intensive study of representative compositions of the sixteenth through the twentieth centuries for structure and form. ½ unit. Prerequisite: Music 104 and 109, or consent of instructor. FARRELL.

309. **Seminar in Music for Dance.** Theory and practice of combining sound and movement in theatrical dance. Individual projects providing experience in collaboration for both composers and choreographers. ½ unit. Prerequisite: Music 106, 306, or Dance 265 and/or consent of instructor. A. R. THOMAS.

310. **Ancient and Medieval Music.** A history of music from its origins to about 1400. ½ unit. Prerequisite: Music 131 or 214, or consent of instructor. MACDONALD.

311. **Music in the Renaissance.** A history of music from about 1400 to 1600. ½ unit. Prerequisite: Music 131 or 214, or consent of instructor. HAMM.

312. **Music of the Seventeenth Century.** A history of music from about 1600 to 1700. ½ unit. Prerequisite: Music 131 or 214, or consent of instructor.

313. **Music of the Eighteenth Century.** A history of music from about 1700 to 1800. ½ unit. Prerequisite: Music 131 or 214, or consent of instructor. TEMPERLY.

314. **Music of the Nineteenth Century.** A history of music from about 1800 to 1900. ½ unit. Prerequisite: Music 131 or 214, or consent of instructor. MACDONALD.

315. **Music of the Twentieth Century.** A history of music from about 1900 to the present. ½ unit. Prerequisite: Music 131 or 214, or consent of instructor.

316. **Introduction to Music of the World's Cultures.** Same as Anthropology 316. An introduction to non-Western and folk music, to the role of music in the world's societies, and to the methods of collecting and studying music in non-literate, folk, and Asian high cultures. For students outside the School of Music. ½ unit. Prerequisite: Anthropology 103 or consent of instructor. NETTL.

317. **Area Studies in Ethnomusicology.** Same as Anthropology 315. A seminar devoted to intensive study in the music of one specific culture, e.g., (a) Japan, (b) China, (c) Indonesia, (d) India, (e) the Near East, (f) African and New World Negro, (g) European and American folk cultures, (h) American Indian. ½ unit; maximum accumulated credit, 2 units. Prerequisite: Senior standing in music or consent of instructor. NETTL.

318. **History of Performance Practices, I.** The study of musical performance from about 900 to 1600. Discussion of musical instruments, makeup of instrumental and vocal ensembles, etc., are supplemented by demonstration performances of selected works using the University's collection of instruments. ½ unit. Prerequisite: Senior standing in music theory and music history or consent of instructor. HUNTER.

319. **History of Performance Practices, II.** The study of musical performance from 1600 to 1750. Discussion of musical instruments, ornamentation, basso continuo, etc., are supplemented by demonstration performances using the University's collection of instruments. ½ unit. Prerequisite: Senior standing in music theory and music history or consent of instructor. HUNTER.

320. **Proseminar.** Provides special preparation in specialized fields of musicology, music education, theory, and composition. ½ or 1 unit; maximum accumulated credit, 2 units. Prerequisite: Senior or graduate standing in music or music education; consent of instructor. GRADUATE FACULTY.

321. **Proseminar in Musicology.** A practical introduction to research in musicology, devoted each time to intensive study of a selected topic, including the use of

primary source materials, lectures, and reports. 1 unit; maximum accumulated credit, 2 units. Prerequisite: Graduate standing in musicology or consent of instructor. KELLMAN.

322. **Introduction to Musicology.** A survey of the various fields open to musicological research, both systematic and historical, with bibliographical studies and elementary problems for investigation. ½ or 1 unit; maximum accumulated credit, 2 units. Prerequisite: Senior or graduate standing in music, or consent of instructor. HAMM.

323. **Opera Production, I.** Designed to help interested students on the graduate level to study the problems of the lyric stage. Casting methods, program selection, production procedures, stage direction, coaching methods, and opera dramatics are investigated and practiced. ½ unit. Prerequisite: Music 265 and 381; consent of instructor. ZIRNER.

324. **Opera Production, II.** Designed to help interested students on the graduate level to study the problems of the lyric stage. Casting methods, program selection, production procedures, stage direction, coaching methods, and opera dramatics are investigated and practiced. ½ unit. Prerequisite: Music 323. ZIRNER.

329. **History of Musical Instruments.** The evolution of instruments, both Western and non-Western, considered in their social and cultural settings; construction and playing techniques of instruments treated in relation to performance practice and stylistic developments. ½ unit. Prerequisite: Music 213 and 214, or consent of instructor. NETTL.

330. **Applied Music Pedagogy.** A survey of techniques, practices, and materials; presentation of group and individual instruction; an approach to teaching problems, tone production, musical styles and interpretation for various age levels. Actual teaching experience under faculty supervision. Required of applied music majors in piano and string instruments. ½ unit; maximum accumulated credit, 1 unit. Prerequisite: Consent of instructor. LYKE, MILLER, ROLLAND, G. WILSON.

332. **Church Music Literature.** A survey of the development of church music with emphasis on the period since 1500. ½ unit. Offered in 1969-1970 and in alternate years. Prerequisite: Music 214 or 311, or consent of instructor. HAMILTON.

333. **Church Music Techniques.** The technical problems of the church musician: chanting, liturgical practices, organization, repertoire. ½ unit. Prerequisite: Music 332 or consent of instructor. HAMILTON.

334. **The Music of America, I.** A study of folk, popular, and art music in America from the time of the first European settlers through the middle of the nineteenth century; psalmody, early opera and concert life, African and European folk music, the singing school, music of European immigrants, and the roots of jazz. ½ unit. Prerequisite: Senior standing in music or consent of instructor. BEHAGUE.

335. **The Music of America, II.** A study of chamber, choral, and orchestral music written by American composers from 1850 to the present; jazz and its offshoots; folk and popular music, and experimental music in America. ½ unit. Prerequisite: Senior standing in music or consent of instructor. BEHAGUE.

336. **Music in Latin America.** Studies in the history of music in Latin America from colonial times to the present, including its cultural and social background. Each semester is devoted to a specific area, e.g., Caribbean America and Venezuela, Colombia and the Andean nations, Brazil and the River Plate nations. A reading knowledge of Spanish or Portuguese is recommended. ½ or 1 unit; maximum accumulated credit, 2 units. Prerequisite: Consent of instructor.

340. **Instrumental Clinic and Band Pageantry.** A study of the pecularities of the individual instruments, criteria for selection, and accepted teaching methods and procedures for each instrument. Band pageantry deals with formation designing,

charting and show continuity, marching fundamentals, and special problems. ½ unit. Prerequisite: Advanced undergraduate or graduate standing, with major work or experience in band or orchestra. KISINGER.

341. **Advanced Instrumental Administration.** Administration of bands and orchestras in public schools and colleges. 1 unit. Prerequisite: Advanced undergraduate or graduate standing, with major work or experience in band or orchestra. KISINGER.

342. **Percussion Methods.** Designed primarily for teachers of school music who may or may not be percussion performers, but who wish to teach percussion and initiate such a program in the schools. ½ unit. Prerequisite: Senior or graduate standing in music education; Music 174 and 257, or equivalent. MCKENZIE.

344. **Methods of String Class Teaching.** Designed primarily for teachers of school music who are not performers on a string instrument, yet would like to be able to teach string classes and start an orchestral program in the schools. S; ½ unit. Prerequisite: Senior or graduate standing in music education or consent of instructor.

345. **Teaching Techniques of Music Theory.** Teaching materials, methods, texts, and pedagogical sequence are discussed and analyzed, including an intensive survey of the structural materials normally covered during the first two years of collegiate study. ½ unit. Prerequisite: Music 300 or consent of instructor. CARTER.

346. **Workshop in Music Education.** Workshop designed to develop essential facts, attitudes, and principles through a consideration of problems encountered in music education. Parallel with this study is the preparation of resource materials for music programs in elementary and secondary schools. S; ½ or 1 unit; maximum accumulated credit, 2 units. Prerequisite: Senior or graduate standing in music education or consent of instructor. BERGETHON, LEONHARD, R. E. THOMAS.

347. **Teaching of Woodwind Instruments.** Designed primarily for teachers of instrumental music in the public schools. S; ½ unit. Offered in 1968 and in alternate years. Prerequisite: Senior or graduate standing in music education or consent of instructor. MCDOWELL, WOODWIND FACULTY.

348. **Teaching of Brass Instruments.** Designed primarily for teachers of instrumental music in the public schools. S; ½ unit. Offered in 1969 and in alternate years. Prerequisite: Senior or graduate standing in music education or consent of instructor. SEXTON, BRASS FACULTY.

349. **Music in Early Childhood.** Same as Home Economics 349. A detailed consideration of the music program in nursery schools, kindergarten, and the primary grades. Topics covered include the nature of early musical responses, objectives, and experience levels of the program, methods of teaching, and materials. Observation of music teaching in the Child Development Laboratory is included in the course work. ½ unit. Prerequisite: Senior or graduate standing in music education or child development. SMITH.

350. **Advanced Ensemble Music.** Selected projects in the study and performance of ensemble literature including the areas of operatic, instrumental, and vocal-choral literature and accompanying. ½ unit; S, ¼ unit. Prerequisite: Registration in applied music at the 300 level; consent of instructor. GARVEY, HUNTER, SWENSON, ZIRNER.

Applied Music

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

Private instruction on the advanced undergraduate and graduate level. Prerequisite: Completion of comparable course at the 100 level; qualifying examination for transfer students.

377. Class Piano (Advanced). An integrated course in piano instruction with emphasis placed upon the acquisition of keyboard knowledges and skills essential for effective school music teaching; includes work in harmonization, transposition, improvisation, and vocal and instrumental score reduction. ½ unit. Prerequisite: Music 104, 109, 180, or consent of instructor. LYKE.

380. Piano. ½ or 1 unit; S, ¼ or ½ unit. FLETCHER, KARP, RICHARDS, SANDERS, STRAVINSKY.

381. Voice. ½ or 1 unit; S, ¼ or ½ unit. BAILEY, BOWEN, BURDETTE, CLARK, CRAWFORD, FOOTE, KELLOGG, MILLER, REYNOLDS, G. WILSON.

382. Organ. ½ or 1 unit; S, ¼ or ½ unit. HAMILTON, PETTINGA.

383. Violin. ½ or 1 unit; S, ¼ or ½ unit. ROLLAND, SCHMITT.

384. Viola. ½ or 1 unit; S, ¼ or ½ unit. GARVEY.

385. Cello. ½ or 1 unit; S, ¼ or ½ unit. FARRELL, SWENSON.

386. String Bass. ½ or 1 unit; S, ¼ or ½ unit. KROLICK.

387. Flute. ½ or 1 unit; S, ¼ or ½ unit. DELANEY.

388. Clarinet. ½ or 1 unit; S, ¼ or ½ unit. COGGINS, MCDOWELL.

389. Oboe. ½ or 1 unit; S, ¼ or ½ unit. EDLEFSEN.

390. Bassoon. ½ or 1 unit; S, ¼ or ½ unit. BERRY.

391. Cornet and Trumpet. ½ or 1 unit; S, ¼ or ½ unit. SEXTON.

392. French Horn. ½ or 1 unit; S, ¼ or ½ unit. HOLDEN.

393. Trombone. ½ or 1 unit; S, ¼ or ½ unit. GRAY.

394. Baritone. ½ or 1 unit; S, ¼ or ½ unit. NUTAITIS.

395. Tuba. ½ or 1 unit; S, ¼ or ½ unit. NUTAITIS.

396. Percussion. ½ or 1 unit; S, ¼ or ½ unit. MCKENZIE.

397. Harp. ½ or 1 unit; S, ¼ or ½ unit. ROSENFIELD.

398. Saxophone. ½ or 1 unit; S, ¼ or ½ unit. COGGINS.

399. Harpsichord. ½ or 1 unit; S, ¼ or ½ unit. HUNTER.

NUCLEAR ENGINEERING

Nuclear engineering offers work leading to the Master of Science and Doctor of Philosophy and provides courses and research facilities for doctoral candidates in nuclear engineering and related fields.

The programs in nuclear engineering are open to all graduates in engineering, mathematics, and the physical sciences who have a grade-point average of at least 4.0 out of 5.0 for the last two years of undergraduate work. Students with grade-point averages below 4.0 but above 3.5 are considered individually. Applicants who fall in this latter category are invited to support their applications with a letter explaining the circumstances. It is recommended that they also submit letters of reference and information as to their rank in class.

Undergraduate courses in differential equations, advanced calculus, atomic physics, and nuclear physics are required as background for the nuclear engineering program. A student may be admitted before he has a completed these four prerequisites, but he must then allow an additional semester or summer of study for completion of the master's degree.

The general requirements of the Graduate College must be met for either degree.

A candidate for the M.S. degree who does not submit a thesis must complete nine units of graduate work.

A three-megawatt TRIGA Mark II reactor is located on campus for research and teaching in nuclear engineering. The reactor can be pulsed to power levels of 5,000 megawatts for special studies. Teaching facilities include a nuclear metallurgy laboratory, a radiochemistry and nuclear instrumentation laboratory, a boiling water heat transfer loop, several subcritical natural uranium assemblies, a waste disposal laboratory, a shielding laboratory, and a direct energy conversion laboratory.

For further information, see the brochure *Graduate Program in Nuclear Engineering*, available from the Nuclear Engineering Office, 216 Nuclear Engineering Laboratory.

GRADUATE FACULTY

Professors: M. E. Wyman (Chairman of Nuclear Engineering Program), F. T. Adler, A. W. Allen, R. W. Bohl, A. P. Boresi, B. T. Chao, A. B. Chilton, B. B. Ewing, L. Goldstein, C. D. Hendricks, J. P. Hummel, J. S. Koehler, R. J. Martin, M. S. McVay, G. H. Miley, J. E. Pearson, S. L. Soo.

Associate Professors: J. H. Austin, R. A. Axford, G. A. Costello, O. L. Gaddy, D. F. Hang, J. T. Verdeyen.

Assistant Professors: B. G. Jones, H. Merkelo, N. H. Schilmoeller, B. H. Wehring.

COURSES FOR GRADUATES

401. **Fundamentals of Nuclear Engineering.** A lecture and problem course to provide background for further work in nuclear engineering. Problems in materials, heat transfer, and fluid flow. Special emphasis is given to basic ideas and the mathematical similarity of problems in heat transfer, fluid flow, and neutron diffusion. 1 unit. Prerequisite: Physics 282 or 382 and Mathematics 345, or equivalent, or consent of instructor.

411. **Nuclear Reactor Heat Transfer.** Selected topics in nuclear reactor heat transfer: thermal analysis of fuel elements under steady and transient operation, convective energy transport from reactor cores, two-phase flow and boiling in reactor cores, and liquid metal coolant systems. ¾ to 1 unit. Prerequisite: Nuclear Engineering 401 or consent of instructor.

421. **Nuclear Concepts.** Selected topics in low-energy nuclear physics of general interest to the nuclear engineering field; nuclear reactions, cross sections, slowing down and interactions with matter, decay theory, and nuclear forces. 1 unit. Prerequisite: Physics 282 or 382; consent of instructor.

431. **Nuclear Metallurgy.** Metallurgical principles applied to materials problems in nuclear engineering, including topics in production of uranium, corrosion, radiation damage, fuel element fabrication, and fuel reprocessing. 1 unit. Prerequisite: Consent of instructor.

441. **Nuclear Radiation Shielding.** Radiation units and measurement; tolerance limits; interaction of radiation and matter; geometry factors in attenuation; gamma ray and neutron attenuation; moment theory for attenuation; application to reactors, protective shelters, and space vehicles. 1 unit. Prerequisite: Nuclear Engineering 347, Mathematics 343 and 345, or consent of instructor.

447. **Radioactive Waste Disposal.** Same as Civil Engineering 447. Sources and characteristics of radioactive wastes; methods of treatment; ultimate disposal; fate of radioisotopes in the environment; permissible levels in air and water; current levels in water supplies; water treatment methods; monitoring techniques; solid waste disposal; gaseous waste disposal; air monitoring; and reactor site selection

and hazards evaluation. ½ or 1 unit. Prerequisite: Physics 282 or Chemistry or Nuclear Engineering 398, or consent of instructor.

451. Reactor Laboratory. Reactor operation: start-up, changes in power level, and shutdown. Reactor instrumentation: subcritical assemblies; flux measurements in core and thermal column; control rod worth measurements; effects of changes in fuel configurations; activation and neutron beam experiments. ½ or 1 unit. Prerequisite: Consent of instructor.

454. Nuclear Engineering Laboratory Investigations. Individual laboratory investigations in nuclear engineering. ½ to 1½ units. Prerequisite: Consent of instructor.

455. Reactor Physics, I. Same as Physics 455. An introduction to the physical concepts of reactor analysis; nuclear cross sections; diffusion, slowing down, and thermalization of neutrons; homogeneous reactor theory; introduction to heterogeneous reactor theory and reactor kinetics; computer applications in reactor analysis. 1 unit. Prerequisite: Mathematics 343 and 345, Nuclear Engineering 347, or consent of instructor.

456. Reactor Physics, II. Same as Physics 456. Neutron transport theory; current methods of solution of the transport equation; fast and thermal neutron spectra; applications in heterogeneous reactor analysis and other areas of reactor physics; digital computer methods. 1 unit. Prerequisite: Nuclear Engineering 455 or consent of instructor.

458. Nuclear Reactor Engineering. Development of engineering design phases of the fission chain reactor: reactor materials and radiations, thermal aspects, heat removal, radiation hazards, shielding, reactor performance, controls and instrumentation, types and applications, fuel conversion, reactor power economics. 1 unit. Prerequisite: Consent of instructor.

460. Reactor Kinetics. Discussion of special topics such as response of reactor systems to changes of power demand and reactivity. Transfer function analysis, nonlinear problems of reactor dynamics, reactor stability; fuel cycles; digital and analog computer methods for solving reactor kinetic problems. 1 unit. Prerequisite: Nuclear Engineering 401 and 455, or consent of instructor.

467. Thermomechanics of Nuclear Reactor Systems. Same as Theoretical and Applied Mechanics 467. Origin of thermomechanics problems in nuclear reactor systems; heat generation and transfer in nuclear power systems; thermal stress in nuclear reactor systems; dynamical theory including effects of thermal shock and thermal stress-wave propagation; current thermomechanics problems in nuclear reactor design. Term paper required. 1 unit. Prerequisite: Nuclear Engineering 401 or consent of instructor.

490. Special Topics. Selected areas are considered which are of current interest in research, such as nuclear materials, advanced reactor systems, thermonuclear problems, digital computer methods in nuclear engineering, advanced topics in reactor theory. ½ or 1 unit. Prerequisite: Consent of instructor.

495. Nuclear Engineering Problems. Individual study in areas of nuclear engineering and closely related fields not covered by regular course offerings. The work is carried out under the supervision of a member of the staff. ½ to 2 units. Prerequisite: At least three units of graduate work; consent of instructor.

497. Seminar in Nuclear Science and Engineering. Lectures and discussions on current work in research and development in nuclear engineering and related fields by staff, advanced students, and visting lecturers. No credit.

499. Thesis Research. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

347. **Introduction to Nuclear Engineering.** Nuclear particles and nuclear chain reactions, energy release from fission; classification of nuclear reactors; fast and thermal reactors; reactor theory; slowing down and diffusion of neutrons; radiation shielding; materials of construction, radiation damage; reactor instrumentation, safety, and control; chemical processing of nuclear materials. ¾ or 1 unit. Prerequisite: Physics 282 or 382 and senior standing in engineering, or consent of instructor.

349. **Fundamentals of Radiation Protection.** Same as Civil Engineering 349. Principles and practice of health physics and radiation protection engineering, including such topics as: principles of dosimetry, sources of ionizing radiation; determination of radiation tolerances; dosimetric instruments; standards and regulations. ¾ or 1 unit. Prerequisite: Credit or registration in Nuclear Engineering 397 or Physics 382, or equivalent.

397. **Radiochemistry.** Same as Chemistry 397. Properties of radioactive nuclei, nature of radioactivity, nuclear structure, nuclear reactions, interactions of radiations with matter, chemical aspects of radioactivity work, and applications of nucleonics to chemistry. ¾ unit. Prerequisite: One semester of physical chemistry, or one semester of atomic physics, or consent of instructor.

398. **Radiochemistry Laboratory.** Same as Chemistry 398. Radioactivity detection and tracer applications of radioisotopes in chemistry and other fields. One laboratory and one discussion period per week. ½ unit. Prerequisite: One semester of physical chemistry, or one semester of atomic physics, or consent of instructor.

NUTRITIONAL SCIENCES

Graduate training programs in the nutritional sciences are offered by the Departments of Animal Science, Dairy Science, Food Science, and Home Economics. Programs are available which lead to either the Master of Science or Doctor of Philosophy degree.

The degree requirements are designed to provide the basic knowledge of those disciplines (such as biochemistry, physiology, and microbiology) which is necessary for productive research in the broad field of the nutritional sciences, along with advanced training in an area of specialization. Opportunities for thesis research in the participating departments range from metabolic studies at the cellular or molecular level to applied problems pertaining to the nutrition of domestic animals and man. Information pertaining to general admission requirements is given in the departmental sections of this catalog. Inquiries should be directed to individual departments.

PHILOSOPHY

The Department of Philosophy offers work leading to the Master of Arts and Doctor of Philosophy.

Students beginning graduate work with philosophy as their major subject are expected to have a grade-point average of at least 4.0 for the last sixty hours of work completed. Applications of students whose grade-point averages are below 4.0 but above 3.75 are considered on an individual basis, as are also all applications for entrance with advanced standing.

In addition, students applying for admission in philosophy should have had courses in logic, ethics, history of philosophy, and theory of knowledge. Students with deficiencies are required to take one or more of the following courses: Philosophy 102

(or 333), 321, 303, 306, or 330, in addition to meeting the minimum requirements of eight units for the master's degree.

Master of Arts. A candidate for this degree must choose at least one course in each of the following three fields: history of philosophy; theory of knowledge, including logic, philosophy of science, and philosophy of language; and theory of value, including ethics, aesthetics, social philosophy, and philosophy of religion. In addition to completing eight units of graduate work, the candidate must take an oral examination on the work represented by these units, including his master's thesis.

Doctor of Philosophy. A candidate carries on (1) major studies in one of three fields within the department; (2) minor studies amounting to at least two units in each of the two remaining fields; and (3) minor studies amounting to at least two units in a department other than philosophy. The candidate's choice of major and minors must be approved by the department.

The candidate must pass a preliminary examination, write a dissertation of publishable quality, and pass a final examination on the dissertation.

A detailed statement of the special departmental requirements for graduate students can be obtained from the Department of Philosophy, 105 Gregory Hall.

GRADUATE FACULTY

Professors: B. J. Diggs (Chairman of Department), A. H. Donagan, M. H. Fisch, A. R. Turquette, F. L. Will.

Associate Professors: C. E. Caton, H. M. Tiebout.

Assistant Professors: H. S. Chandler, R. N. Faber, R. L. Schacht, F. R. Suppe, J. J. Valberg, J. D. Wallace.

COURSES FOR GRADUATES

401. Seminar in Ancient Philosophy. 1 unit. May be repeated for credit. Fisch.

403. Seminar in Medieval Philosophy. 1 unit.

405. Seventeenth-Century Continental Thought (Descartes, Spinoza, Leibniz). A study of the basic philosophical works of the three leading continental thinkers of the century. 1 unit. Donagan.

407. British Empiricism. 1 unit. Turquette.

408. German Idealism (Kant). 1 unit.

409. Recent American Philosophy. Major American philosophers and movements since about 1900. Reports and discussions. 1 unit. Fisch.

411. Seminar in Recent Ethical Theory. 1 unit; may be repeated for a maximum of 2 units. Diggs.

412. Seminar in Social Philosophy. A seminar designed to study special problems in social philosophy. Particular attention is given to the contributions of the social sciences to social philosophy. To be offered with varying topics. 1 unit. May be repeated for credit. Diggs.

413. Logical Theory. 1 unit. Prerequisite: A course in logic or consent of instructor. Turquette.

415. Seminar in Metaphysics. Intensive study of a selected topic of major importance in the field of metaphysics. 1 unit. May be repeated for credit.

417. Seminar in the Philosophy of Science. Various problems arising from specific studies in philosophy pertaining to science and vice versa. To be offered with varying topics. 1 unit. May be repeated for credit.

420. **Seminar in Semantics.** Same as Communications 420. Intensive study of important contemporary contributions in the fields of semantics, analytic philosophy, and the philosophy of language. 1 unit. CATON.

421. **Seminar in Contemporary Problems.** Intensive study of selected problems or topics in contemporary philosophy, with particular emphasis on questions of knowledge and value. 1 unit. May be repeated for credit.

422. **Seminar in Contemporary Problems.** Intensive study of selected problems or topics in contemporary philosophy, with particular emphasis on questions of knowledge and value. 1 unit. May be repeated for credit.

423. **Seminar in the Theory of Knowledge.** Selected topics and writings of major importance in the contemporary philosophy of knowledge. 1 unit. May be repeated for credit. WILL.

424. **Seminar in the Theory of Knowledge.** Selected topics and writings of major importance in the contemporary philosophy of knowledge. 1 unit. May be repeated for credit. WILL.

425. **Seminar in the Philosophy of Mind.** Selected topics from major writings in the philosophy of mind. 1 unit. May be repeated for credit.

430. **Seminar in Modern Aesthetics.** 1 unit.

439. **Seminar in the Philosophy of Mathematics.** Detailed examination of important questions arising from philosophical and logical analyses of mathematics. 1 unit. May be repeated for credit. Prerequisite: Consent of instructor.

483. **Individual Topics.** Individual study and oral written reports on topics not covered in other courses. Not more than one unit may be counted toward the A.M. degree and not more than two toward the Ph.D. degree. Topics and plan of study must be approved by the candidate's adviser and by the staff member who directs the work. ½ to 2 units. STAFF.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. **History of Greek and Roman Philosophy.** 1 unit. FISCH.

304. **History of Medieval Philosophy.** Lectures and reading in the history of philosophy from St. Augustine to William of Ockham. ¾ or 1 unit. Prerequisite: Philosophy 101 or 303.

306. **History of Modern Philosophy.** 1 unit. DONAGAN.

307. **History of Modern Philosophy.** Bacon, Hobbes, Locke, Berkeley, Hume. Philosophy 307 and 308 taken concurrently in the summer session are the equivalent of Philosophy 306. S; ½ unit. Prerequisite: Consent of instructor.

308. **History of Modern Philosophy.** Descartes, Spinoza, Leibniz, Kant. Philosophy 307 and 308 taken concurrently in the summer session are the equivalent of Philosophy 306. S; ½ unit. Prerequisite: Consent of instructor.

309. **The Philosophy of Plato.** ¾ or 1 unit. Prerequisite: Philosophy 101 or 303.

310. **The Philosophy of Aristotle.** An intensive study of major works of Aristotle or of some aspect of his philosophy. 1 unit. Prerequisite: Philosophy 101 or 303.

311. **Philosophic Ideas of the Nineteenth Century.** ¾ or 1 unit. Prerequisite: One course in philosophy (preferably Philosophy 101 or 306).

313. **American Philosophy.** The history of philosophy in America from colonial times to the present. ¾ or 1 unit. Prerequisite: One course in philosophy. FISCH.

317. **Great Books in Modern Thought.** Hume, Darwin, Marx, Freud. Reading and discussion of selected books which either have produced or themselves reflect in some important way a changed conception of man and the world. ¾ or 1 unit. Prerequisite: One course in philosophy.

319. **Philosophical Ideas in Latin America.** A survey of the main philosophical currents and thinkers of Latin America. ½ or 1 unit. Prerequisite: One course in philosophy.

321. **Ethics and Value Theory.** ¾ or 1 unit. Prerequisite: One course in philosophy. Caton, Diggs.

322. **Recent Developments in Ethics.** Ethical theories of the last fifty years: intuitionism, naturalism, pragmatism, emotivism, existentialism, analytic ethics. ¾ or 1 unit. Prerequisite: Philosophy 103, 105, or 321.

323. **Philosophy of Art.** A discussion of the main philosophical priniciples of art and of outstanding contemporary philosophies of art. ¾ or 1 unit.

324. **Philosophy of Religion.** ¾ or 1 unit. Prerequisite: One course in philosophy.

325. **Philosophy of Mind.** Philosophical problems arising in connection with mental phenomena; the relation of mind and body; free will and determinism; our knowledge of other minds; the self and personal identity. ¾ or 1 unit. Prerequisite: One course in philosophy.

326. **Metaphysics.** ¾ or 1 unit. Prerequisite: One course in philosophy.

327. **Scientific Method.** Methodology and epistemology; empirical knowledge and learning from experience; science and common sense; scientific explanation; historical examples; generalizing and historical science; natural and social science historicism; explanation in the social sciences. ¾ or 1 unit.

328. **Philosophy of Science.** A study of some philosophical problems that have developed from modern science. ¾ or 1 unit. Prerequisite: One course in philosophy. Turquette.

330. **Theory of Knowledge.** The relative acceptability of authority, intuition, and the method of hypothesis as ways of establishing belief; logical and empirical truth; pragmatism and positivism; other selected contemporary topics. ¾ or 1 unit. Prerequisite: One course in philosophy.

331. **Analytic Philosophy.** Advanced treatment of problems of knowledge and method and introduction to contemporary techniques of philosophical analysis. Meaning and verification; inductive and deductive method; perceptual knowledge; certainty; other selected topics. ¾ or 1 unit. Prerequisite: One course in philosophy.

332. **Perception and Knowledge.** A systematic study of basic problems in the philosophy of perception: perceiving as a mental state; the objects of perception; sensing, sensation, and sense-data; perception and the external world; perception as the basis of empirical knowledge. Traditional empiricist philosophies of perception are examined and contemporary criticisms and defenses are assessed. ¾ or 1 unit. Prerequisite: One course in philosophy.

333. **Symbolic Logic.** A study of the elementary principles of symbolic analysis as applied to logical problems. ¾ or 1 unit. Turquette.

334. **Symbolic Logic.** A general study of the more refined methods of symbolic analysis as applied to logical problems. Particular attention is devoted to proof procedures as they relate to the question of consistency and completeness. ¾ or 1 unit. Prerequisite: Philosophy 333. Turquette.

335. **Social Philosophy.** The nature of social organization as seen from economic, moral, and political standpoints; various senses of freedom; relations between

organization and freedom; the free society. ¾ or 1 unit. Prerequisite: One course in philosophy.

336. **Philosophy of Law and of the State.** ¾ or 1 unit. Prerequisite: One course in philosophy.

337. **Semantics.** An investigation of semantical concepts such as denoting and truth; study of the functions of language, definition, meaning and verification, semantical paradoxes. ¾ or 1 unit. Prerequisite: A course in logic.

338. **Philosophies of Language.** Same as Linguistics 338. A study of the development of philosophical problems about language and the treatment of them from antiquity through the nineteenth century. ¾ or 1 unit. Prerequisite: One course in philosophy. FABER.

339. **Philosophy of Mathematics.** Introduction to some of the main philosophical problems and contemporary viewpoints concerning mathematical concepts, mathematical methods, and the nature of mathematical truths. The concept of infinity; conventionalism and formalism; the distinction between analytic and synthetic truths; necessity; mathematics and the problem of universals; other related topics. ¾ or 1 unit. Prerequisite: One course in philosophy.

340. **The Philosophy of Alfred North Whitehead.** An examination of the mature thought of A. N. Whitehead, primarily as contained in *Process and Reality* and *Adventures of Ideas*, taking into account both the cosmological scheme and the application of his technical philosophy to social philosophy, to ethics, and to philosophy of religion. ¾ or 1 unit. Prerequisite: One course in philosophy. TIEBOUT.

341. **Existential Philosophy.** A study of a selection of the major writings of the more important existential philosophers, e.g., Heidegger, Jaspers, Sartre. ¾ unit. Prerequisite: One course in philosophy (preferably Philosophy 311).

350. **Philosophy and Modern Life.** A study of the relation between philosophy and contemporary life, including an analysis and discussion of the philosophical principles involved in the artistic, intellectual, cultural, and social developments of the modern world. ¾ or 1 unit. Prerequisite: One course in philosophy.

361. **Comparative Religions: The Religions of the East.** A comparative philosophical analysis of the philosophic doctrines and the mythologies of Hinduism, Buddhism, and Taoism, with incidental reference to Jainism, Sikhism, Confucianism, and Shinto. ¾ or 1 unit. Prerequisite: One course in philosophy. TIEBOUT.

362. **Comparative Religions: The Religions of the West.** A comparative philosophical analysis of the philosophic doctrines and religious symbols of Judaism, Christianity, and Islam. ¾ or 1 unit. Prerequisite: One course in philosophy. TIEBOUT.

363. **Contemporary Religious Thought.** An analysis of contemporary philosophical developments in Judaism, Christianity, and Islam, with particular emphasis upon "Neo-orthodox" Protestant thought. ¾ or 1 unit. Prerequisite: One course in philosophy. TIEBOUT.

PHYSICAL EDUCATION

The department offers programs of graduate study leading to the Master of Science in the Teaching of Physical Education and the Master of Science and Doctor of Philosophy in Physical Education. Both programs are centered in training teachers, administrators, and research workers in the general field of physical education, including sport, dance, and exercise. The Doctor of Philosophy program also permits candidates to specialize in the areas of health education, safety education, and recre-

ation. (See Health and Safety Education, page 207, and Recreation and Park Administration, page 346.)

Admission requirements for a major in the field are: (1) a minimum grade-point average of 4.0 for the last sixty hours of undergraduate study (applicants whose averages are below 4.0 but above 3.75 are considered on an individual basis); (2) thirty hours of approved credit in physical education or related fields; (3) eighteen hours of approved undergraduate credit in science; (4) sixteen hours of undergraduate credit in education; and (5) a course in statistics or measurement. Graduate Record Examination aptitude and achievement test scores, as well as a Miller Analogies Test score, should be submitted to the department.

Master of Science in Physical Education. Candidates for the Master of Science in Physical Education must complete eight units including (1) four units in physical education or approved related courses (health education or recreation); (2) two approved units in another discipline directed toward a specific research interest; (3) Physical Education 490, one semester, no credit; (4) thesis, two units.

Master of Science in the Teaching of Physical Education. Candidates for this degree must complete eight units including (1) four units in physical education or approved related courses (health education or recreation); (2) two units in education including Educational Psychology 311 and 312 and two of the following: History and Philosophy of Education 301, 302, 303, and 304; (3) Physical Education 490, one semester, no credit; (4) thesis, two units. The Master of Science in the Teaching of Physical Education option is designed to meet the needs of fifth-year students who do not intend to pursue the doctorate. See pages 45 and 46.

Candidates for the Master of Science in the Teaching of Physical Education may petition to waive the thesis and seminar requirements, but they must take two additional units of credit and pass a final comprehensive written and/or oral examination in physical education and related fields.

Doctor of Philosophy. Requirements for this degree are twenty-four units of credit including (1) a minimum of eight units in physical education courses or approved related courses in health education, safety education, or recreation; (2) written proficiency in two foreign languages, usually French and German or Russian; (3) one minor for a minimum of four units, or two minors for a minimum of two units each; (4) Physical Education 490; and (5) presentation of an acceptable thesis of eight units.

GRADUATE FACULTY

Professors: E. F. Zeigler (Head of Department), Alyce T. Cheska, T. K. Cureton, Jr., A. W. Hubbard, Laura J. Huelster, C. G. Knapp, D. O. Matthews, K. J. McCristal.

Associate Professors: Phyllis Hill, W. Johnson, G. Lueschen, A. C. Moore, Jr., R. H. Pohndorf, R. E. Shelton, Olive G. Young.

Assistant Professors: B. D. Franks, Nell C. Jackson, J. E. Razor, B. L. Rothermel, Marianna Trekell.

COURSES FOR GRADUATES

401. **Administration of Physical Education and Sport.** Analysis of completed research relating to theory and practice of administration in physical education and sport; the development of policy statements and procedures manuals for the various educational levels; experience in the use of the case plan of instruction as a teaching technique for the development of competencies and knowledges relating to human relations and administration in this specialized field. 1 unit. Prerequisite: Physical Education for Men or Physical Education for Women 204 or equivalent. Huelster, Matthews, Zeigler.

402. **History of Physical Education and Sport.** An analysis of the research literature related to the historical foundations of physical education and sport; discussion of such persistent historical problems as the influence of economics, politics and nationalism, curriculum and methods of instruction, professional preparation, the healthy body, dance, the use of lesiure, and amateur and professional sport. 1 unit. Prerequisite: Physical Education for Men or Physical Education for Women 209 or equivalent. TREKELL, ZEIGLER.

406. **Philosophy of Physical Education and Sport.** Philosophical analysis of physical education and sport (with some reference to school health and recreation) in the light of the leading philosophical tendencies and possible implications for public and private education; analysis of completed research; includes delineation of one's personal philosophy and the use of philosophical analysis as a research technique. 1 unit. Prerequisite: Philosophy 101; History and Philosophy of Education 305. HUELSTER, ZEIGLER.

407. **Sport Psychology.** Analysis of psychological factors and principles with special reference to motor performance, learning motor skills, preception and emotion in sport situations; review of literature; independent projects. 1 unit. Prerequisite: Psychology 100; Educational Psychology 211; consent of instructor. HUBBARD, YOUNG.

408. **Principles of Kinesiotherapy.** Analysis of medically approved techniques employed in the treatment of disease and injury by exercise and movement; kinesiological evaluation of principles involved; therapy preparation in teaching techniques; medically prescribed clinical training; literature; research. 1 unit. Prerequisite: Anatomy, physiology, kinesiology and physiology of exercise, or consent of instructor. SHELTON.

451. **Scientific Foundations of Physical Fitness.** Scientific basis for physical fitness; analysis of fitness programs and fitness tests; techniques in remedial clinics; literature; research. Includes laboratory session. 1 unit. Prerequisite: Undergraduate anatomy and physiology, tests and measurements. CURETON, POHNDORF.

452. **Scientific Analysis of Physical Education Activities.** Analysis of selected activities in terms of physiological, anatomical, physical mechanics, and kinesiological features, involving both cinematographical and metabolic methods. Includes laboratory session. 1 unit. Prerequisite: Anatomy, physiology, kinesiology, elementary physics, algebra, and trigonometry, or consent of instructor. CURETON.

453. **Anthropometrical and Body Mechanics Research Techniques.** Critical analysis of the techniques of anthropometrical and body mechanics measurements; analysis of selected research studies; laboratory and computational projects in biophysical study. 1 unit. Prerequisite: College algebra and trigonometry; Physical Education 495 and 451. CURETON.

490. **Seminar.** Lectures, discussions, and critiques on physical education and related subjects by faculty members and visiting professional leaders; presentation and criticism of student theses. No credit. CURETON, POHNDORF, TREKELL, STAFF.

493. **Special Projects.** Independent research on special projects. Offered summers as special group practicums. ½ or 1 unit. STAFF, VISITING FACULTY.

495. **Techniques of Research in Health and Physical Education.** Review and appraisal of common research procedures; application of statistical procedures, library methods, evaluation procedures, and experimental methods. 1 unit. HUBBARD, POHNDORF, TREKELL.

499. **Thesis Research.** Preparation of theses in physical education. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

302. **Problems of Facilities Planning, Construction, and Utilization.** Physical education facilities as related to objectives of physical education; consultant

services with planning committees and architects; cost factors in different types of construction; the use of standards as a check on and guide for planning; safety factors; changes in playing surfaces due to research; building and field maintenance problems. ½ unit. Prerequisite: Physical Education for Men or Physical Education for Women 204 or equivalent, or consent of instructor.

303. **International Physical Education and Sport.** A study of objectives, methods, personnel, facilities, and evaluation of selected national programs of physical education. Additional consideration is given to sports clubs, indigenous games, and research. ½ unit. Prerequisite: Physical Education for Men 209 or Physical Education for Women 209, or consent of instructor.

350. **Theory and Practice of Exercise Therapy.** Theory and practice of therapeutic exercise as it applies to physical rehabilitation of the physically handicapped; physiological and kinesiological principles of physical restoration; the physical educator's role as related to ancillary medical forces; problems and principles related to kinesiotherapy, preventive, adapted, and remedial physical education and athletic training. 1 unit. Prerequisite: Anatomy, physiology, physiology of exercise, and kinesiology; or consent of instructor. SHELTON.

PHYSICAL SCIENCES

A special program leading to the Master of Science in the Physical Sciences is available to meet the needs of secondary school teachers who wish to get a broad view of the physical sciences rather than to specialize in one department. Since the program is designed primarily for those preparing to teach the physical sciences, chemistry and physics are emphasized. Students working toward degrees under the provisions of this program are expected to seek approximately equal proficiency in both physics and chemistry; those whose undergraduate work has emphasized chemistry should balance this by weighting the graduate work in favor of physics, and vice versa. No thesis is required, and all courses in physics, chemistry, geology, astronomy and mathematics which normally give graduate credit are acceptable toward the degree. To qualify for the degree, a student must present at least one course in mathematics beyond calculus, for which calculus is prerequisite. In addition, he must have met the requirements for teacher certification.

Candidates for the Master of Science in the Teaching of the Physical Sciences, which is distinct from the program described above, must earn four units in the physical sciences, two units in education, and two units in electives. The two units in education must include the following courses: History and Philosophy of Education 304 and 305, one unit; and Educational Psychology 311 and 312, one unit. The courses in the physical sciences and the electives—which must normally give graduate credit—must be selected with the approval of the adviser. The electives may be in the physical sciences, in education, or, in exceptional cases, in other fields. Students applying for admission must have a grade-point average of at least 3.5. See pages 45 and 46.

Inquiries concerning these programs should be directed to Professor Don Secrest, 155 Noyes Laboratory.

PHYSICS

The Department of Physics offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy in Physics.

There is opportunity for specialization in atomic and nuclear physics, including research with the betatrons, the cyclotron, and with radioactive sources; in nuclear magnetic resonance; in theoretical physics; in the physics of solids, including research

on ionic crystals, metals, semiconductors, cryogenics, and surface physics; in plasma physics and aeronomy.

Requirements for admission to the Graduate College with a major in physics are twenty semester hours of physics, including Physics 321, 341, and 342, or the equivalent, and excluding courses in general physics, and an average of at least 3.75 for the last sixty hours of undergraduate work. Advanced undergraduate courses in light, thermodynamics, and atomic physics are strongly recommended.

The requirements for the Master of Science in Physics are the general requirements of the Graduate College. They may be satisfied by adequate performance in graduate courses, without the submission of a thesis.

Departmental requirements for the Doctor of Philosophy in Physics, in addition to the general requirements of the Graduate College, are described in a pamphlet which may be obtained from the office of the head of the department.

Candidates for the Master of Science in the Teaching of Physics must earn four units in physics; two units in approved electives; Educational Psychology 311, 312, and one additional unit in education selected from History and Philosophy of Education 301, 302, 303, and 304. Students applying for admission must present an average of 3.75 for the last sixty hours of undergraduate work; applications of students with averages below 3.75 but above 3.5 are considered on an individual basis. The adviser for candidates for this degree is Professor G. M. Almy, 209 Physics Building. See pages 45 and 46.

For information concerning applied mathematics, see page 285; for information about biophysics, see pages 92 and 256. A doctoral program in chemical physics is described on page 101.

GRADUATE FACULTY

Professors: G. M. Almy (Head of Department), A. Abashian, F. T. Adler, J. S. Allen, D. Alpert, G. Ascoli, P. Axel, J. Bardeen, F. C. Brown, R. M. Brown, W. D. Compton, L. D. Fosdick, H. Frauenfelder, J. J. Gilman, D. M. Ginsberg, E. L. Goldwasser, A. V. Granato, P. Handler, A. O. Hanson, J. P. Hummel, L. P. Kadanoff, J. S. Koehler, L. J. Koester, P. G. Kruger, U. E. Kruse, L. S. Lavatelli, D. Lazarus, E. M. Lyman, D. E. Mapother, R. J. Maurer, B. H. McCormick, J. R. Pasta, D. Pines, M. Reather, D. G. Ravenhall, C. S. Robinson, G. A. Russell, C. T. Sah, R. D. Sard, C. B. Satterthwaite, R. O. Simmons, C. P. Slichter, J. H. Smith, J. N. Snyder, A. Wattenberg, H. W. Wyld, Jr., M. E. Wyman.

Associate Professors: A. C. Anderson, G. A. Baym, M. K. Brussel, J. H. Cahn, C. P. Flynn, E. A. Jackson, M. V. Klein, R. N. Peacock, F. M. Propst, H. J. Stapleton, W. S. Williams, A. I. Yavin.

Assistant Professors: P. G. Debrunner, B. I. Eisenstein, L. E. Holloway, J. M. Mochel, T. A. O'Halloran, M. B. Salamon, R. L. Schult, J. D. Stack, J. D. Sullivan, D. C. Sutton, M. Wortis, J. A. Wright.

COURSES FOR GRADUATES

400. **Problems and Methods of Mathematical Physics.** Matrices and tensors; analytic functions of a complex variable; conformal mapping; contour integration; ordinary differential equations: solutions at singular points, contour integral solutions, asymptotic expansions; eigenfunctions and eigenvalues; partial differential equations: Laplace's equation, wave equation, diffusion equation, Green's functions; Legendre, Bessel, confluent hypergeometric, Mathieu, and elliptic functions; elementary difference equations. 1 unit. Prerequisite: Mathematics 342, 345, 347, or 387; Physics 322 and 342; or consent of instructor.

422. **Dynamics and Nonlinear Mechanics.** Hamiltonian mechanics: Lagrange equations, Hamilton's canonical equations, contact transformations, Lagrange and Poincaré invariants, Hamilton-Jacobi equation and Huygens' principle; perturbation theory, relaxation oscillations and stability of periodic motion, theory of cosmotron orbits, three-body problems. 1 unit. Prerequisite: Physics 322; Mathematics 345.

424. **Relativity and Cosmology.** Same as Astronomy 424 and Mathematics 460. Elements of tensor calculus and Riemannian geometry; special relativity: Lorentz transformations, equivalence of mass and energy; general relativity and the gravitational field of the sun; galaxies and cosmology. 1 unit. Prerequisite: Consent of instructor.

435. **Theory of Semiconductors and Semiconductor Devices.** Same as Electrical Engineering 435. Introductory quantum mechanics of semiconductors; energy bands; dynamics of Bloch electrons in static and high frequency electric and magnetic fields; equilibrium statistics; transport theory, diffusion, drift and thermoelectric effects; characteristics of p-n junctions, heterojunctions and transistor devices. 1 unit. Prerequisite: Physics 381 or 383.

436. **Selected Topics in Physics of Solids.** The following topics are offered in rotation, one or two each semester.

(a) Imperfections in Metals. Influence of point imperfections such as lattice vacancies and interstitial atoms on diffusion and on such physical properties as resistivity, stored energy, lattice parameter, density; properties of dislocations and stacking faults and their influence on mechanical properties, on physical properties, on crystal growth, and on phase changes. 1 unit. Prerequisite: Physics 490.

(b) Imperfections in Ionic Crystals. Theory of vacancies, interstitial ions, dislocations, and excitons; applications to diffusion, ionic conductivity, chemical reactions in the solid state, and plastic flow; effect of imperfections upon the electronic and optical properties of ionic crystals. 1 unit. Prerequisite: Physics 490.

(c) Magnetic Properties of Solids. Quantum theory of diamagnetism, paramagnetism, ferromagnetism; elements of magnetic resonance and relaxation. 1 unit. Prerequisite: Physics 482 and 490, or consent of instructor.

441. **Electrodynamics.** Electrostatics; Laplace's and Poisson's equations; boundary value problems; spherical harmonics; multiple potentials; dielectrics; microscopic and macroscopic fields; electric susceptibility; magnetostatics; magnetic multipoles; magnetic media; conducting media; Maxwell's equations; field energy and momentum; electromagnetic waves; reflection and refraction; dispersion; wave packets; causality; diffraction; wave guides and cavity resonators; simple aspects of magnetohydrodynamics and plasmas. 1 unit. Prerequisite: Physics 342 or equivalent; registration in Physics 400 or consent of instructor.

442. **Electrodynamics.** Special theory of relativity; covariant formulation of electrodynamics; charged particle dynamics; high energy particle accelerators; energy loss by charged particles traversing matter; multiple scattering; Lienard-Wiechert potentials; radiation by charged particles; radiation loss in particle accelerators; Thomson scattering; bremsstrahlung; Weiszacker-Williams method; inner bremsstrahlung; Cerenkov radiation; radiative reaction; natural line breadth; multiple expansion of radiation field; Lagrangian and Hamiltonian formulation of electrodynamics. 1 unit. Preresquisite: Physics 441.

455. **Reactor Physics, I.** Same as Nuclear Engineering 455. An introduction to the physical concepts of reactor analysis; nuclear cross sections, diffusion, slowing down, and thermalization of neutrons; homogeneous reactor theory; introduction to heterogeneous reactor theory and reactor kinetics; computer applications in reactor analysis. 1 unit. Prerequisite: Nuclear Engineering 347, Mathematics 343 and 345, or consent of instructor.

456. **Reactor Physics, II.** Same as Nuclear Engineering 456. Neutron transport theory; current methods of solution of the transport equation; fast and thermal neutron spectra; applications in heterogeneous reactor analysis and other areas of reactor physics; digital computer methods. 1 unit. Prerequisite: Physics 455 or consent of instructor.

462. **Statistical Mechanics and Kinetic Theory.** Single-particle distribution functions: classical and quantum mechanical systems, Boltzmann equation, virial theorem, equations of state for gases; formal theory: ensembles, identical particles, thermodynamics of simple systems, distribution functions; non-equilibrium problems: conservation laws and hydrodynamics equations, sound waves, transport coefficients; plasmas, normal Fermi fluid, superfluids, systems with internal degrees of freedom. 1 unit. Prerequisite: Physics 360 and elementary quantum mechanics, or consent of instructor.

463. **Low Temperature Theory and Quantum Liquids.** Normal Fermi liquids: equilibrium properties, transport equation, quasi-particle collisions, degenerate He^3, Landau theory; formal description of experimental measurements in neutral and charged Fermi liquids; superfluid Bose liquid: He II, rotating buckets, macroscopic description of superfluid flow, two-fluid model, first, second, and quasi-particle sound, vortex lines, microscopic theory; superconductivity: BCS theory, electrodynamics and coherence effects, superconductivity in metals, tunnel effect, flux quantization, microscopic theory of superfluid flow, vortices. 1 unit. Prerequisite: Physics 362 or 462, and 481, or consent of instructor.

465. **Plasma Physics.** Basic equations of magnetohydrodynamics; orbit theory; stability of plasma configurations; hydromagnetic waves; plasma oscillations; high-frequency instabilities; spontaneous fluctuation theory; Fokker-Planck equation; transport processes; oscillations in a magnetic field; interaction of electromagnetic waves with plasmas. 1 unit. Prerequisite: Physics 362 and 441, or Electrical Engineering 423, or consent of instructor.

467. **Atomic Collision Processes.** Same as Electrical Engineering 467. Elastic collisions of electrons with neutral atoms; inelastic electron-atom and electron-molecule collisions; collisions between heavy particles; molecule formation; photo-processes and recombination; negative ions; collisions involving the emission of radiation; theory of spectral line-broadening in plasmas; experimental techniques. 1 unit. Prerequisite: Physics 481; consent of instructor.

470. **Introduction to Nuclear and Particle Physics.** Basic facts of photons, leptons, hadrons, conservation laws, types of interaction, particle production and stability symmetries, nuclear forces, and ground state properties; two-particle systems: electromagnetic interactions, bound states, and resonances; nucleon-nucleon and meson-nucleon interactions; nuclei: properties of low-lying states, models, resonant reactions, and direct processes; particles and weak interactions: multipion resonances, symmetry schemes, beta decay and other leptonic processes, strange particle decays. 1 unit. Prerequisite: Registration in Physics 482.

471. **Nuclear Physics, I.** Systematics of stable nuclei and the nuclear potential; properties of odd-A nuclei; spherical single particle shell model; residual interactions; collective states and deformed nuclei; summary of theory and experiment for low-lying states; momentum distribution of nucleons; fission. 1 unit. Prerequisite: Physics 470 and 482, or consent of instructor.

472. **Nuclear Physics, II.** Resonance reactions: fast and slow neutron cross sections, neutron and gamma widths, strength functions, giant dipole resonance, compound nucleus, and statistical model; direct reactions: optical model, elastic and inelastic scattering, polarization, angular correlations; spectroscopic factors, intermediate structure, isobaric analogs. 1 unit. Prerequisite: Physics 471.

475. **Particle Physics, I.** Particles: properties and systematics; S-matrix theory; application of symmetry and invariance principles to decays, production processes and polarization; collision processes; mesonic and baryonic resonances; symmetry schemes; particle scattering at very high energies; theory of pion-nucleon scattering, dispersion relations, Mandelstam representation. 1 unit. Prerequisite: Physics 470 and 482, or consent of instructor.

476. **Particle Physics, II.** Electromagnetic interactions of particles, form factor, predictions of unitary symmetry; beta and muon decay and capture, conserved and partially conserved currents, neutrino interactions, weak interaction form factors; leptonic and non-leptonic decays of strange particles; neutral K-meson decays; current topics. 1 unit. Prerequisite: Physics 475.

480. **Quantum Mechanics, I.** Introduction to concepts of quantum theory, with applications. Review of classical Lagrangian mechanics; historical review of quantum phenomena, Bohr theory, and the wave nature of matter; Schrödinger wave equation; one-dimensional potential well and barrier penetration problems; three-dimensional problems, angular momentum, hydrogen atom; simple stationary state perturbation theory, perturbation of energy levels, Stark effect, normal Zeeman effect. 1 unit. Prerequisite: Physics 322 and 342; a course in atomic physics.

481. **Quantum Mechanics, II.** Principally applications to atomic and molecular structure. Electron spin; spin-orbit coupling, anomalous Zeeman effect; semiclassical treatment of emission and absorption of radiation with examples; selection rules, atomic spectra, x-ray spectra; Pauli principle, helium atom, exchange energy; periodic system of elements, Fermi-Thomas atom; diatomic molecules, electronic motion, vibrational and rotational motion, band spectra; simple collision problems, partial wave analysis, Born approximation. 1 unit. Prerequisite: Physics 480 or consent of instructor.

482. **Quantum Mechanics, III.** Formal structure of quantum theory; quantum theory of angular momentum, vector addition coefficients, simple tensor operators; collision problems, inelastic scattering, formal scattering theory; elementary treatment of quantization of the radiation field and the interaction of light with matter; introduction to Dirac electron theory. 1 unit. Prerequisite: Physics 481 and 422, or consent of instructor.

487. **Topics in Advanced Quantum Theory.** The following topics are offered alternately, but not every year.

(a) Advanced Quantum Mechanics. Relativistic quantum mechanics of a single particle; Dirac equation, Lorentz transformation, properties and bilinear covariants, bound state and scattering problems, Möller and Breit interactions, elementary radiation theory, relativistic photoeffect, bremsstrahlung, formal scattering theory, S-matrix, symmetry principles. 1 unit. Prerequisite: Physics 482.

(b) Quantum Field Theory. Field quantization; scalar and pseudoscalar meson field: electromagnetic field, Dirac field, interacting fields, electrodynamics; meson theory; interaction representation; S-matrix; covariant perturbation theory and Feynman diagrams; Compton scattering; Möller scattering; bremsstrahlung; pair annihilation; charge and mass renormalization; Lamb shift; anomalous electron magnetic moment; Heisenberg representation; dispersion relations; recent developments. 1 unit. Prerequisite: Physics 487a.

489. **Solid State Physics, I.** Introduction to the modern theory of crystalline materials. Topics treated include crystal symmetry, elastic and thermal properties of solids, optical properties, point defects and imperfections in crystals. 1 unit. Prerequisite: Physics 360, 362, 381, 480, or consent of instructor.

490. **Solid State Physics, II.** Introduction to band theory of solids, free electron model, electrons in periodic potential, cohesion, transport properties of metals and

semiconductors, experimental methods for determining band structure. 1 unit. Prerequisite: Physics 481, 489, or consent of instructor.

491. Solid State Physics, III. Elementary excitations in solids; phonons, electrons, plasmons, excitons, spin waves, treated as elementary excitations in interaction with one another and with external fields and particles. 1 unit. Prerequisite: Physics 481.

497. Individual Study. Individual study in a subject not covered in course offerings may be arranged for credit by registration under this number. ½ or 1 unit.

498. Special Topics in Modern Physics. Seminar. Lecture courses in topics of current interest are given under this number. Subjects are announed in the Time Table. ½ or 1 unit.

499. Thesis Research. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. Modern Experimental Physics, I. Techniques and experiments in the physics of atoms, atomic nuclei, molecules, the solid state, and other areas of modern physical research. 1 unit. Prerequisite: Physics 342; registration in Physics 381.

304. Modern Experimental Physics, II. Continuation of Physics 303. 1 unit. Prerequisite: Physics 303.

321. Theoretical Mechanics. Motion of a particle in one, two, and three dimensions with applications; Kepler's laws and planetary motion; scattering of particles; conservation laws; motion of a rigid body in two dimensions; statics of extended systems. Lectures and problems. 1 unit; no graduate credit is given to graduate physics majors. Prerequisite: General physics; registration in Mathematics 341, 345, or 349.

322. Theoretical Mechanics. Continuation of Physics 321. Moving coordinate frames, fictitious forces; special theory of relativity, conservation laws, particle motion and creation; rigid body motion in three dimensions; gravitation and earth motion; generalized coordinates and Lagrange's equations; constraints, small vibrations. 1 unit. Prerequisite: Physics 321.

341. Electricity and Magnetism. The fundamental laws are introduced using the vector notation stressing Maxwell's equations in the integral form. Topics covered with applications and problems include direct current circuits, circuit theorems, electric and magnetic fields, Gauss' Law, capacitance and inductance; energy and forces associated with these fields in free space and in matter. Lectures, problems, and laboratory. This course is fundamental to advanced courses and should be elected as early as possible by those intending to specialize in physics. ½ or 1 unit; no graduate credit is given to graduate physics majors. Prerequisite: General physics; credit or registration in Mathematics 341, 343, or 345, or consent of instructor.

342. Electricity and Magnetism. Continuation of Physics 341. Effects associated with changing fields and currents, Faraday's Law, displacement current, transient currents, complex variables in circuit analysis, coupled circuits, and circuit theorems; an introduction to the generation and propagation of electromagnetic waves and the wave equations. ½ or 1 unit; no graduate credit is given to graduate physics majors. Prerequisite: Physics 341.

343. Electronic Circuits. The physics of vaccum tube and semiconductor devices; theory and application of these devices as linear circuit elements in power supplies, amplifiers, communication circuits and control circuits. Emphasis is on experimental techniques. Lectures, problems, and laboratory. 1 unit. Prerequisite: Physics 341 or consent of instructor.

344. Electronic Circuits. Continuation of Physics 343. Electronic instruments and techniques used in research in physics and digital computers; theory and experiments emphasizing the use and design of nonlinear circuits, e.g., multivibrators, pulse generators, counters, etc.; theory of switching circuits; special topics. 1 unit. Prerequisite: Physics 343 or equivalent.

347. Electromagnetic Theory and Boundary Value Problems. Beginning with Maxwell's equations, this course treats electrostatic and magnetostatic boundary value problems and multipole expansions with orthogonal polynomials, boundary value problems in quasistatic and radiation fields, simple radiating systems, and scattering of scalar waves. 1 unit. Prerequisite: Mathematics 343 and 345, Physics 342 or Electrical Engineering 229; or consent of instructor.

360. Thermodynamics. Zeroth, first, second, and third laws of thermodynamics; applications to simple physical and chemical systems; thermodynamic inequalities and equilibrium; phase transitions. Lectures and problems. 1 unit. Prerequisite: General physics and calculus; senior standing in physics is advised.

362. Kinetic Theory and Statistics. A lecture and problem course presenting the fundamentals of kinetic theory and an elementary introduction to statistical mechanics. Topics covered include the distribution law, equations of state, viscosity, diffusion, thermal conduction, Maxwell-Boltzmann, Bose, Einstein, and Fermi-Dirac statistics and applications. 1 unit. Prerequisite: Physics 360 or consent of instructor.

366. Aeronomy: Physics of the Upper Atmosphere and Space. Same as Astronomy and Electrical Engineering 366. Structure and composition of the Earth's upper atmosphere; solar radiation and its interaction with the upper atmosphere; the ionospheric layers; planetary atmospheres; airglow and aurora; interplanetary plasma; the magnetic field of the Earth and its interaction with the solar plasma; experimental techniques. 1 unit. Prerequisite: Physics 342, 321 and 381, or consent of instructor.

371. Light. Wave optics: description and superposition of waves, coherence, interference, diffraction, polarization, and dispersion. Geometrical optics: image formation, optical systems, thick lens theory, image defects; applications to optical instruments. Lectures, problems, and laboratory. ½ to 1 unit. Prerequisite: General physics; Mathematics 345 or consent of instructor.

381. Atomic Physics. Same as Chemistry 396. A lecture and problem course presenting our modern knowledge of the nature and properties of electrons, light quanta, atoms, and molecules. Topics covered include evidence for the atomic nature of matter, the properties of free electrons and ions, photons and their interaction with matter, atomic spectra and structure, molecular spectra and structure, and an introduction to the ideas of quantum mechanics. 1 unit. Prerequisite: General physics and Mathematics 343 or 345; registration in Physics 385 is recommended.

382. Nuclear Physics. A lecture and problem course presenting our modern knowledge of the properties of nuclear particles, natural and artificial radioactivity, laboratory equipment for producing and studying high energy particles, nuclear disintegrations, the interaction of nuclear particles with each other and with matter, cosmic rays, mesons, and recent developments in high energy nuclear physics, and the application of nuclear phenomena to some practical problems. 1 unit. Prerequisite: Physics 381 or 383.

383. Atomic Physics and Quantum Theory for Engineers. Introduction to the basic concepts of quantum theory which underlie modern theories of the properties of materials. Topics covered include elements of atomic and nuclear theory, kinetic theory and statistical mechanics, quantum theory, and simple applications, atomic spectra and atomic structure, molecular structure and chemical binding.

Lectures and problems. ¾ or 1 unit. Prerequisite: General physics; general chemistry; Mathematics 345 or equivalent.

385. **Introduction to Quantum Mechanics.** Experimental foundation; basic postulates; Schrödinger wave equation; hydrogen atom; superposition of states; the calculation of energy, position, momentum and angular momentum; steady state perturbation theory; identical particles, time-dependent perturbation theory; introduction to Dirac theory. The course emphasizes basic principles applied to simple examples, many of them one-dimensional. Numerical methods for the solution of eigenvalue problems are used extensively. Recommended to physics majors and also to students in other physical sciences and engineering. 1 unit. Prerequisite: Mathematics 343, Mathematics 345, or consent of instructor; registration in Physics 381 is recommended.

386. **Atomic Physics and Quantum Mechanics, I.** Study of atomic phenomena integrated with an introduction to quantum theory; topics discussed include evidence for the atomic nature of matter and the properties of the Schrödinger equation, single particle solutions in one dimension, the hydrogen atom, perturbation theory, external fields, and atomic spectroscopy of outer electrons. 1 unit. Prerequisite: General physics; Mathematics 343 or 345, or consent of instructor.

387. **Atomic Physics and Quantum Mechanics, II.** Continuation of Physics 386. Topics treated include identical particles, spectral hyperfine structure, magnetic properties of matter, atomic spectroscopy of inner electrons, high energy photon effects, molecular binding and spectra, emission and absorption of light, and symmetry principles. 1 unit. Prerequisite: Physics 386.

PHYSIOLOGY AND BIOPHYSICS

See descriptions and course listings under Life Sciences, page 255.

PLANT PATHOLOGY

Graduate work leading to the Master of Science and Doctor of Philosophy is available in the Department of Plant Pathology. Students may choose a major, joint major, or minor in plant pathology. The following fields are available for specialization: diseases of field crops, forest and shade trees, fruit crops, ornamentals, turf and lawn grasses, and vegetable and canning crops. The student may also specialize in plant virology, nematology, fungicides, antibiotics, physiology of fungi, and biochemistry of plant diseases.

A candidate for the Master of Science must meet the general requirements of the Graduate College, present an acceptable thesis, and pass an oral examination before a committee of staff members. The examination covers courses which the candidate has completed and those in which he is currently registered.

Candidates for the Doctor of Philosophy must meet the general requirements of the Graduate College regarding foreign languages, special examinations, minors, and theses.

Beginning graduate students are accepted with a grade-point average of 3.75. Applications of students with grade-point averages of 3.5 and below 3.75 are considered on an individual basis.

GRADUATE FACULTY

Professors: W. M. Bever (Head of Department), L. M. Black, J. C. Carter, J. L. Forsberg, J. W. Gerdemann, D. Gottlieb, A. L. Hooker, M. B. Linn, D. Powell, M. C. Shurtleff, H. H. Thornberry.

Associate Professors: M. P. Britton, P. D. Shaw, D. P. Taylor.
Assistant Professors: D. W. Chamberlain, H. Jedlinski, J. D. Paxton.

COURSES FOR GRADUATES

401. Diseases of Forest and Shade Trees. A survey of the history, symptomatology, causes, and control of diseases of trees, with assigned reading and performance of illustrative experiments in the laboratory, greenhouse, and field. Offered in 1968-1969 and in alternate years. ½ or 1 unit. Prerequisite: Plant Pathology 204 or consent of instructor. Carter.

403. Physiology of Fungi. Same as Botany 403. The germination, growth, metabolism, and sporulation of fungi; physiology of the fungi as related to parasitism, antibiotic production, vitamin assay, and industrially important products. The nature of fungicidal activity is discussed. 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Plant Pathology 204, or equivalent; organic chemistry or biochemistry; mycology and microbiology. Gottlieb.

404. Plant Virology. Fundamental concepts; classification, symptomatology; infectivity; biological, chemical, and physical properties; techniques for transmission, straining, assay, filtration, and purification; control methods; sources of information; history of virology. ½ or 1 unit. Offered in 1968-1969 and in alternate years. Prerequisite: Consent of instructor. Thornberry.

406. Genetics of Plant-Pathogen Interactions. The genetics and expression of resistance in plants to fungi, bacteria, viruses, nematodes, and other pathogens; variation and genetic systems in pathogens with particular emphasis on pathogenicity; complementary genetic systems; theory and practice of breeding disease resistant plants. Lectures, discussions, assigned reading, and term paper. 1 unit. Offered in 1968-1969 and in alternate years. Prerequisite: Plant Pathology 204 and Botany 210, or Agronomy or Horticulture 323, or consent of instructor. Hooker.

417. Discussions in Plant Pathology. Discussion of current research, literature, and other topics pertaining to plant pathology and related fields. ¼ unit. Staff.

499. Thesis Research. Individual study and research required of all students working toward the Master of Science or Doctor of Philosophy in Plant Pathology. 0 to 4 units. Prerequisite: Plant Pathology 302 or equivalent. Work can be taken in the following areas, subject to approval of the staff member concerned:

(a) Biochemistry of Plant Disease. Staff.
(b) Diseases of Corn; Genetics of Resistance. Hooker.
(c) Diseases of Cereal Grains. Bever, Hooker, Shurtleff.
(d) Diseases of Forest and Shade Trees. Carter.
(e) Diseases of Fruit Crops; Fungicides. Powell.
(f) Diseases of Leguminous Crops; Root Diseases. Gerdemann.
(g) Diseases of Turf and Lawn Grasses. Britton.
(h) Diseases of Soybeans. Chamberlain.
(i) Diseases of Vegetable and Canning Crops. Linn, Shurtleff.
(j) Nematode Diseases. Taylor.
(k) Physiology of Fungi; Antibiotics. Gottlieb, Shaw.
(l) Plant Virology. Black, Jedlinski, Thornberry.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Special Problems. For students desiring to study specific problems not assigned in other courses. ¼ to 1 unit; maximum accumulated credit, 2 units. Staff.

302. Research Methods in Plant Pathology. Techniques for the isolation, identification, culture of, and inoculation with plant pathogens; methods for the histological

study of diseased plants; recording of data. ¾ unit. Prerequisite: Plant Pathology 204 or equivalent. PAXTON.

303. **Plant Nematology.** Experimental techniques, nematode anatomy, taxonomy, biology, and host-parasite relations; intensive study of selected groups including foliar, stem, root-knot, and cyst nematodes; interaction with bacteria, fungi, and viruses in plant disease development; control principles. ¾ unit. Offered in 1968-1969 and in alternate years. Prerequisite: Plant Pathology 204 or equivalent; an introductory course in zoology or biology. TAYLOR.

304. **Forest Tree Diseases and Wood Deterioration.** Symptoms, causal agents, and control of the major forest tree diseases; causes and control of wood deterioration. ¾ unit. GERDEMANN.

305. **Principles of Plant Disease Control.** A study of the basic concepts of both nonchemical and chemical methods used for the control of plant diseases. Lectures, discussions, and assigned reading. ¾ unit. Offered in 1969-1970 and in alternate years. Prerequisite: Plant Pathology 204; Chemistry 102, 132 or 133; or consent of instructor. POWELL.

306. **Epiphytology and Diagnosis of Plant Diseases.** Detailed consideration of factors influencing the incidence and severity of diseases caused by fungi, bacteria, viruses, and nematodes; ecological factors as etiological agents, and techniques for determining the intensity of epiphytotics; plant disease identification. ¾ unit. Offered in 1969-1970 and in alternate years. Prerequisite: Plant Pathology 204 or equivalent. BRITTON.

377. **Diseases of Field Crops.** Same as Agronomy 377. A study of the symptoms of the major field crop diseases, life histories of causal organisms, and methods of control. ¾ unit. Offered in 1969-1970 and in alternate years. Prerequisite: Plant Pathology 204 or equivalent. HOOKER.

POLITICAL SCIENCE

The Department of Political Science offers work leading to the degrees of Master of Arts and Doctor of Philosophy. Graduate work is conducted in the following special fields: American government and politics, comparative government and politics, international law and relations, political behavior, political theory and jurisprudence.

Admission to graduate work in political science requires a grade-point average of at least 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis. The student must also have had a minimum of twenty hours of undergraduate work in political science, economics, finance, sociology, or history, not less than twelve hours of which must have been in political science (which may include three hours in constitutional history).

The department also administers a program leading to the Master of Arts in Public Administration. A grade-point average of at least 3.75 and a study proposal leading to a well-defined career or professional objective, approved by the department, are required for admission. The program is offered both in Urbana and through extramural classes in Springfield, and is matched to the invididual needs and objectives of students. Programs for students without public service employment usually incorporate an internship of at least three months. Further details may be obtained from the department, 326 Lincoln Hall.

Graduate students in other departments who choose political science as a minor must have at least six hours of undergraduate work in political science and three hours in other social sciences.

Language Requirement. The language requirement for the doctorate may be met in either of two ways: (1) The student may demonstrate, in the manner prescribed by the Graduate College, reading proficiency in two languages other than English. Of these,

one must be French, German, or Russian; the other may be any language which, in the opinion of the thesis adviser, will be useful to the student in his research program, and for which testing facilities are available on the Urbana campus. (2) The student may demonstrate, in the manner prescribed by the Graduate College, a high degree of proficiency in one language other than English for which testing facilities are available on the Urbana campus, provided that this language will be useful to him in his research program or in his capacity as a professional political scientist. For the purpose of establishing such utility, the student, prior to his admission to the preliminary examinations, must have completed one or more research reports, e.g., term papers, articles, or theses, based extensively on written materials in the language concerned.

GRADUATE FACULTY

Professors: P. Monypenny (Head of Department), L. J. Barker, R. Dangerfield, G. W. Fisher, S. K. Gove, E. G. Lewis, R. E. Scott, C. F. Snider, V. A. Thompson.

Associate Professors: M. Davis, Betty Glad, G. Manner, S. S. Nagel, T. Page, G. T. Yu.

Assistant Professors: S. P. Cohen, S. A. Douglas, W. E. Steslicke, M. G. Weinbaum.

COURSES FOR GRADUATES

400. Classics of Political Science. Reading, analysis, and discussion of leading works on politics and government. 1 unit. Staff.

401. History of Political Theories. Reading and analysis of the leading political thinkers from the Greeks to the middle of the seventeenth century. 1 unit.

402. History of Political Theories. Readings and analysis of the leading political thinkers from the middle of the seventeenth century to the present. 1 unit.

406. Municipal Administration. Position of cities in American governmental systems; governmental interrelationships; powers; services; current municipal problems. 1 unit.

410. Problems in Rural Local Government. Research in selected topics. 1 unit. Snider.

412. Problems in State Government. Research in selected topics in American state government. 1 unit. Snider.

420. Formation of Public Policy. Same as Labor and Industrial Relations 420. An examination of the institutional and dynamic forces that shape the making of policy and its administration in the United States; separation of powers, pressure groups, administrative and legislative procedures, judicial activity. 1 unit.

421. Government and the Economic Order. Seminar in problems of government regulation of economic activity. This course is concerned with research materials, research papers, and related matters. 1 unit.

425. Personality and Political Process. Rationality and its limits in political processes: the functions of symbols and myth in politics; political involvement and quiescence; nonrational elements in legislation and administration. 1 unit. Prerequisite: Consent of instructor.

426. Political Parties. Special problems in political parties; methods and materials of research in this field. 1 unit.

427. Psychological Base of Political Behavior. This course is intended to introduce the student to relations between psychological mechanisms and life history

factors and individual or group political behavior. Topics covered include national loyalty and ideology, mass public and political involvement, political authority, and individual compliance. 1 unit.

430. **Proseminar in Comparative Politics.** Comparative political analysis in the context of the evolution of the social sciences and modern political science, with emphasis on theories of political action and their function in contemporary comparative studies. This course is designed as an introduction to area oriented seminars and generally is a prerequisite for them. 1 unit.

431. **Problems of British Government.** Special topics relating to British government. 1 unit. LEWIS.

435. **Problems in the Government of Soviet Russia.** Special topics relating to the government of the Soviet Union. 1 unit.

437. **Problems in Chinese Politics and Government.** Research in selected topics relating to the political system of China. 1 unit; may be repeated for credit not to exceed 2 units. Prerequisite: Credit or registration in Political Science 430, or consent of instructor.

440. **Comparative Politics and the Political Process.** The comparative study of selected national political systems or of specific institutional forces that influence the making and application of public policy in several countries. The countries studied and the legal and extra-legal political agencies considered vary according to the person conducting the seminar. 1 unit; may be repeated for credit not to exceed a total of 3 units. STAFF.

441. **Politics in the Developing States.** An examination of the political processes in the developing countries. The general problems arising in the transition from traditional societies to modern industrial states are examined to describe the typical patterns of political change. Special attention is given to contemporary literature and studies. 1 unit. Prerequisite: Political Science 430 and consent of instructor. SCOTT.

442. **Problems of Latin-American Politics and Government.** Special topics relating to Latin-American politics and government. Individual countries may be studied or comparative analysis of particular political and governmental functions or problems may be undertaken. 1 unit; may be repeated for credit not to exceed a total of 2 units. Prerequisite: Political Science 430 and 431 or equivalent. SCOTT.

446. **Problems of Southeast Asian Politics and Government.** Research in the political systems of Southeast Asia. 1 unit; may be repeated for credit not to exceed 2 units. Prerequisite: Credit or registration in Political Science 430, or consent of instructor.

448. **Problems in Japanese Politics and Government.** Study of scholarly literature on modern Japanese politics and examination of selected problems in modern Japanese politics. 1 unit; may be repeated for credit not to exceed 2 units. Prerequisite: Credit or registration in Political Science 430, or consent of instructor.

449. **Problems of South Asian Politics and Government.** Research in the political systems of South Asia. 1 unit; may be repeated for credit not to exceed 2 units. Prerequisite: Credit or registration in Political Science 430, or consent of instructor.

450. **Contemporary Governmental Problems.** Special problems of current importance. Designed especially for students not majoring in political science. 1 unit; may be repeated for credit not to exceed a total of 3 units. STAFF.

451. **Constitutional Law.** Research in selected topics in the American constitutional system. 1 unit. Prerequisite: Political Science 351 or equivalent. NAGEL.

465. Problems in Administrative Management. An analysis of methods of applying administrative principles and procedures to operating problems in government agencies, such as methods of administrative coordination and control, intergovernmental cooperation, legislative-administrative relations, the organization of regulatory functions, and review of administrative decisions. 1 unit. Prerequisite: Political Science 361 or consent of instructor. MONYPENNY, PAGE.

466. Current Administrative Theory. A discussion of some recent trends in administrative opinion and practice on such questions as agency structure and functional activities; field and regional organization and relations; the role and functions of the executive; the process of decision-making; the relations of line and staff activities; the communication and execution of policies and programs; and employee relations. 1 unit. MONYPENNY, THOMPSON.

471. Problems in International Organization. Methods and materials of research in international organization; special topics, such as disarmament, security, procedural problems in the United Nations, economic and social problems, amendment and revision of the Charter. 1 unit.

481. Foreign Relations of the United States. Special problems in the development and conduct of American foreign policy. 1 unit. DANGERFIELD.

484. International Relations. An analysis of the approaches and methods used in the study of international relations; the characteristics of states and of international systems; the problem of conflict and its resolution. 1 unit.

485. International Law. Research on selected topics. 1 unit. MANNER.

490. Proseminar in Political Behavior. Interdisciplinary approaches to the analysis of political behavior; formation of opinions, interests, roles, and personality; applications of organization theory to political institutions; applications of conflict and bargaining theory to political processes; systematic studies of the distribution of values. 1 unit.

491. Proseminar in Political Behavior. Interdisciplinary approaches to the analysis of political behavior; formation of opinions, interests, roles, and personality; applications of organization theory to political institutions; applications of conflict and bargaining theory to political processes; systematic studies of the distribution of values. 1 unit. Prerequisite: Political Science 490.

493. Research in Selected Topics. Research in selected topics by arrangement with the instructor. ½ to 3 units. STAFF.

495. Scope and Methods of Political Science. Definitions of the scope and subject matter of political science; methodological issues in political science; major conceptions of methodology as embodied in current leading studies of politics; the present state of research in political science. 1 unit. MONYPENNY.

496. Political Concepts: Formulation and Measurement. The course is designed to indicate the relevance of certain research techniques for answering questions of concern in political science and to indicate the range of tools available to the student. Problems in concept formation are discussed. Current methods of concept measurement are presented to the student in the context of political research problems. 1 unit. Prerequisite: Consent of instructor.

497. Research Design and Techniques. This course is intended to introduce the student to problems of research design, data collection, data analysis and interpretation, sampling, and some simple measures of statistical association and significance. 1 unit. Prerequisite: Political Science 496.

499. Thesis Research. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

305. **Municipal Government.** Growth of cities; their legal status; municipal politics and organization in the United States. ½ or 1 unit.

306. **Muncipal Problems.** Municipal administration in the United States; administrative organization; personnel problems; financial problems, city planning and housing; police and fire administration; public health; public utilities. ½ or 1 unit. Prerequisite: Political Science 305, or Economics 102 and 103, or six hours of political science.

310. **Rural Local Government.** Development of local government in rural America; state-local relationships; legal status of local units; organization and functions of counties, townships, school districts, and special-purpose districts; rural politics and elections; local finance; problems of reorganization. ½ or 1 unit. SNIDER.

312. **State Government.** The states in the federal system; state constitutions and problems of revision; organization, powers, and functions of the legislative, administrative, and judicial branches of state government; state functions; reorganization problems in the states; state-local relations; state finance; trends and prospects. Students are not given credit for both Political Science 110 and 312. ½ or 1 unit. Prerequisite: Political Science 150 or 191. SNIDER.

315. **Legislatures and Legislation.** The legislative function in government; structure and organization of American legislatures, national, state, and local; party organization in legislatures; legislative procedure, pressure groups and lobbying; relation of legislature to other branches of government; problems of legislative reorganization. ½ or 1 unit. Prerequisite: Six hours of political science.

317. **The American Federal System.** The nature, justification, and problems of federalism; coordination of governmental efforts by contract, subsidies, and grants; comparison of federal systems, ½ or 1 unit. Prerequisite: Political Science 150 or 191. FISHER.

318. **Tax Politics and Administration.** Interactions among the administrative, legal, and legislative aspects of the fiscal decision-making process at federal, state, and local levels, with emphasis on current issues. ½ or 1 unit. Prerequisite: Political Science 150 or 191. FISHER.

321. **Government and the Economic Order.** A survey of public policies of national and state governments regulating economic activity; transportation, electrical utilities, communications, anti-monopoly, agriculture, level of economic activity. ½ or 1 unit. Prerequisite: Two courses in political science or in political science and economics.

326. **American Political Parties.** Organization and operation of the American party system; relations between national, state, and local organizations; state and national committees; the convention system; the primary; campaign methods and finance. ½ or 1 unit. Prerequisite: Political Science 150 or 191, or consent of instructor. WEINBAUM.

328. **Introduction to the Study of Political Behavior.** An analysis of the interrelations of political attitudes and public policy formation. Special attention is given to the substantive areas of voting behavior, political leadership, and the rise of political mass movements. The course also includes a review of the literature on democratic and authoritarian personality types. ½ or 1 unit. Prerequisite: Political Science 150 or equivalent.

329. **Electoral Behavior.** A study of the social and psychological motivations behind the individual voting decision, with special emphasis on the relationships between the voting decision and social stability. ½ or 1 unit. Prerequisite: Six hours of political science. MILLER.

331. **British Government.** Nature of the British constitution; the crown, ministry, and cabinet; Parliament and elections; the party system; law and the courts; local government; the British Commonwealth. ½ or 1 unit. Davis, Lewis, Steslicke.

335. **Government and Politics of the Soviet Union.** Evolution, structure, and functioning of the Soviet system of government; the theories, structure, and functioning of the Communist party of the Soviet Union. ½ or 1 unit.

336. **Governments and Politics in Western Continental Europe.** An analysis of the major governmental systems of Continental Europe; the evolution, structure, and functioning of the political institutions of France, Germany, Italy, Spain, Switzerland, and the Scandinavian countries as illustrations of multiparty and dictatorial types of governments. ½ or 1 unit. Lewis.

337. **Government and Politics of China.** An introduction to the governments and politics of modern China. ½ or 1 unit. Prerequisite: Six hours of political science.

338. **Governments and Politics in the Middle East.** An analysis of the transformation of Middle Eastern society from Morocco to Iran as case studies in political modernization. The politics of the area is studied with special reference to causes and character of modernization, role of leadership, ideologies, and institutions; methods and theories for analyzing political systems undergoing fundamental transformation, and implications for United States policy. ½ or 1 unit. Prerequisite: Six hours of political science.

339. **Governments and Politics in Sub-Saharan Africa.** Analysis of major political systems in Africa south of the Sahara. Emphasis on the development of states and the modification of social and political systems. A general survey of the area is supplemented by a focus on selected countries. ½ to 1 unit. Prerequisite: Six hours of political science.

340. **The German Political System.** Structures and processes of postwar German politics, with primary emphasis on West Germany; special attention is paid to foreign policy formulation and problems, particularly defense, the Berlin issue, reunification, and relations with Eastern Europe. ½ or 1 unit. Prerequisite: Knowledge of German helpful, but not necessary.

342. **Government and Politics in Latin America.** A survey of the origin and development of Latin-American political institutions; systems of government; public administrative systems; party government; international policies of Latin-American governments. ½ or 1 unit. Prerequisite: Six hours of political science. Scott.

343. **Political Systems and Structures of Latin-American Countries.** The political process, generally of selected Latin-American countries at different levels of political development, with stress on the interaction between political infrastructure and more formal agencies of government. May include cross-national comparison of the function of such factors as political culture, party system, bureaucracy, or the military establishment. ½ or 1 unit. Prerequisite: Political Science 342. Scott.

345. **Theory and Practice of Democratic Government.** Theories of the nature and conditions of democracy; contemporary democratic institutions compared and analyzed. ½ or 1 unit. Prerequisite: Political Science 150 or 191.

346. **Theory and Practice of Communism.** A survey of the international Communist movement; the origins of modern communism and the nineteenth-century development of its doctrines; the Russian Revolution; Lenin and Stalin, the U.S.S.R. as a model for communism; the regional development of Communist parties. ½ or 1 unit.

347. **Governments and Politics of Southeast Asia.** A comparative analysis of the political development of the countries of Southeast Asia, the lands to the east of India and south of China, emphasizing the differing approaches to the governing

of man and the formation of public policy to be found in these countries. Economic, social, historical, and geographical influences on political development are considered. ½ or 1 unit. Prerequisite: Six hours of political science or consent of instructor.

348. **Government and Politics of Japan.** An introduction to the government and politics of modern Japan. ½ or 1 unit. Prerequisite: Six hours of political science.

349. **Governments and Politics of South Asia.** A comparative analysis of the political development of India, Pakistan, Ceylon, and the lesser lands of South Asia, emphasizing the differing approaches to the governing of man and the formation of public policy to be found in these countries. Economic, social, historical, and geographical influences on political development are considered. ½ or 1 unit. Prerequisite: Six hours of political science or consent of instructor.

350. **Introduction to Law.** An introductory study of the nature of law, the functions of private law, the functions of public law, social change and law, and the limits of effective legal action. ½ or 1 unit. NAGEL.

351. **American Constitutional System.** Judicial interpretation of the constitution; separation of governmental powers; relation of state and national governments; control of interstate commerce; jurisdiction of courts. ½ or 1 unit. Prerequisite: Political Science 150 or 191. NAGEL.

352. **Comparative Constitutional Law.** A comparative analysis of the constitutional law cases from a variety of countries with particular emphasis on how the cases have resolved issues relating to civil liberties and the allocation of power among governmental bodies. ½ or 1 unit. Prerequisite: Political Science 150 or 191. NAGEL.

354. **The Judicial Process.** A systematic analysis of legal, evidentiary, environmental, and personal factors that influence judicial decision-making, with particular emphasis on the application of the scientific method to the study of judicial behavior. ½ or 1 unit. Prerequisite: Political Science 150 or 191. NAGEL.

355. **The Constitution and Civil Liberties.** A study of free speech, loyalty in a democratic state, citizenship, freedom of religion, rights of persons accused of crime, and government's responsibility to protect persons from racial and religious discrimination, with special attention to the role of law and judges. ½ or 1 unit. Prerequistie: Political Science 150 or 191. NAGEL.

356. **Public Administration and the Judicial Process.** The scope of administrative powers and their relation to private rights. A comparison of the processes of decision in administrative agencies and in the courts; the interests served by each; the impact of judicial review of administrative decisions upon administrative procedure and policy; the constitutional and statutory bases of review; the legal accountability of public officers versus political accountability. ½ or 1 unit. Prerequisite: Political Science 305 or 351, or consent of instructor. NAGEL.

357. **The Process of Law Enforcement.** Problems in the procedure of law enforcement including the nature and ramification of crime; the nature and sources of law; character and types of criminal law; structure of the court system and its role in criminal enforcement; agencies of law enforcement—federal, state, and local; interstate crime control; the police and crime detection; prosecution of criminal offenses; problems of judicial procedure; and correctional procedures. ½ unit. Prerequisite: Political Science 150 or 151.

359. **Jurisprudence.** Nature and sources of law; law and the state; law and justice; evolution, arrangement, and subject matter of law. ½ or 1 unit. Prerequisite: Political Science 150 or 191. MANNER.

361. **Introduction to Public Administration.** Development of administrative organizations; administration and the executive, legislative, and judiciary; principles of

organization, including line and staff relationships; the staff services of finance and personnel; formal and informal control. ½ or 1 unit. Prerequisite: Political Science 150 or 191. MONYPENNY, PAGE.

362. **Administrative Organization and Policy Development.** Dynamics of policy formulation in public administrative agencies; current developments in organizational theory and their significance for public administration; origin of public administrative organizations; interpersonal behavior; large-scale organizations and centralization; external support and opposition; policy formation and problems of compliance. ½ or 1 unit. Prerequisite: Six hours of political science or consent of instructor.

365. **Government and Labor.** Same as Labor and Industrial Relations 365. Critical analysis of the relationship between group pressures on government and public policy affecting labor; role of administration in formation of policy; problems and experience of federal agencies operating in the labor fields. ½ or 1 unit. Prerequisite: Political Science 150 or 191.

366. **Tools of Public Management.** A critical survey of the tools of analysis available to overhead functions of public management in key areas of decision; emphasis on personnel administration and manpower utilization, budgetary processes and fiscal controls, and several methods of administrative analysis—organizational studies, procedures engineering, information processing, and operations research. 1 unit. Prerequisite: Political Science 361 or consent of instructor. MONYPENNY, PAGE.

371. **World International Organization.** General development and basic principles of world organization; principles, structure, methods, and actual operation of international governmental institutions; special attention to the United Nations and related agencies and to their evolution from the League of Nations system. ½ or 1 unit.

372. **Regional International Organizations.** Descriptive and comparative analysis of various regional international organizations, their role in contemporary politics and their relationship to the United Nations system; structure, functions, and accomplishments of North Atlantic Treaty Organization, Southeast Asia Treaty Organization, Organization of American States, and other regional international organizations. ½ or 1 unit. STESLICKE.

380. **Comparative Foreign Policies.** An analysis of the formulation and substance of the foreign policies of select nations of the world. ½ or 1 unit. Prerequisite: Political Science 184 or consent of instructor.

381. **American Foreign Relations.** Participation in international affairs; presidential initiative; development and organization of the Department of State; diplomatic intercourse; consular service; treaty-making power; development of foreign policy. ½ or 1 unit. Prerequisite: Six hours of political science. GLAD.

382. **Contemporary American Foreign Policies.** Study of the major foreign policy decisions currently confronting the United States government: analysis of background, principal issues, alternative actions, formulation of policies. ½ or 1 unit. Prerequisite: Political Science 381 or consent of instructor. DANGERFIELD, GLAD.

383. **Soviet Foreign Policy.** A survey of Soviet foreign policy from 1917 to the present, with emphasis upon the forces shaping this policy. Special attention is given to the interplay of ideology and national interest in policy formulation. ½ or 1 unit.

385. **International Law.** Nature, sources, and development of international law and certain basic rights and obligations of the subjects thereof. ½ or 1 unit. MANNER.

386. **International Law.** Responsibility, intercourse, and redress of differences between states. ½ or 1 unit. MANNER.

387. **National Security Policy.** An examination of the organization and formulation of current American defense policy; the theory of deterrence, with special reference to American and Soviet military strategy; the problems of disarmament and arms control. ½ or 1 unit. Prerequisite: Political Science 184 or consent of instructor.

388. **The Military and Politics.** The role of the military in national and international politics, with special attention given to theories of war and peace, civil-military relations, the military and the political development of Western and non-Western states, and the non-military uses of the military. ½ or 1 unit. Prequisite: Political Science 184 or 192, or consent of instructor.

389. **Chinese Foreign Policy.** An analysis of the formulation, substance, and conduct of Chinese foreign policy, with emphasis on the period since 1949. Special attention is given to the forces shaping Chinese policy. ½ or 1 unit. Prerequisite: Six hours of political science or consent of instructor.

390. **Methods of Political Analysis.** Presentation of the analytic processes in the development of concepts, hypotheses, and theories. Discussion of the derivation, formulation, and specification of research problems to be related to basic methodologies and modes of analysis. Applications to political science. ½ or 1 unit. Prerequisite: Political Science 150 or 191, or consent of instructor.

393. **History of Political Theory.** A survey of the major trends and issues in European political thought. Greek and Roman theories of politics; the development of Christian political thought and the Middle Ages; political theory during the Renaissance, Reformation, and the Counter-Reformation; early modern absolutism, the emergence of constitutional government, and the theory of democracy; the Enlightenment; European liberalism, conservatism, Utopianism, and socialism. ½ or 1 unit.

396. **Contemporary Political Theory.** Major tendencies in Western political theory since 1850; conservatism and constitutionalism; the religious interpretation of the state and economic institutions; Marxism, socialism, and communism; antidemocratic thought and totalitarian regimes. ½ or 1 unit.

397. **American Political Theory.** A survey of American political thought from colonial times to the present. ½ or 1 unit. Offered in 1969-1970 and in alternate years.

PSYCHOLOGY

The Department of Psychology offers graduate work leading to the degrees of Master of Arts, Master of Science, Doctor of Philosophy, and Doctor of Psychology.

Fields. Doctor of Philosophy programs are offered in the following special areas of psychology: general experimental psychology, personality, social psychology, psychological measurement, clinical and counseling psychology, industrial psychology, school psychology, child development, and psycholinguistics. The Master of Arts degree is awarded to students in the above programs as an intermediate degree.

Master of Science programs are offered in personnel psychology, applied experimental psychology, measurement psychology, school psychology, and clinical and counseling psychology.

The Doctor of Psychology program is restricted to clinical and counseling psychology.

Admission. The candidate for the Master of Arts or Doctor of Philosophy must meet the following departmental requirements: (1) a minimum of fifteen hours in psychology; (2) a laboratory course in experimental psychology and a course in statistics; (3) a one-year course in another laboratory science; (4) a grade-point average of 4.0, though this may be waived for a student from a highly selective institution; (5) high

scores on the Graduate Record Examination. Preference is given to students who have taken mathematics beyond college algebra and two years of a foreign language important for research and scholarship in psychology.

The candidate for the Master of Science program must ordinarily have completed an undergraduate major in applied psychology at the University of Illinois. Students with an average of 3.5 may apply.

The candidate for the Doctor of Psychology must meet the following departmental requirements: (1) a minimum of twenty hours in psychology; (2) a course in statistics and a course in tests and measurements; (3) a minimum of twenty hours selected from anthropology, economics, education, political science, social work, and sociology; (4) a grade-point average of 4.0, though this may be waived for a student from a highly selective institution; (5) high scores on the Graduate Record Examination.

Because it is necessary to limit admissions to graduate study in psychology, it is not possible to accept all applicants who meet the minimal requirements for any of the above programs.

Minor. The prerequisite for a graduate minor in psychology is nine semester hours in undergraduate psychology and a course in statistics.

Requirements for Degrees. The Master of Arts is awarded to candidates who complete satisfactorily eight units of work, including an acceptable thesis. The Doctor of Philosophy is awarded to candidates who go on to complete an approved program in their area of specialization and meet Graduate College requirements for the degree.

The Master of Science is awarded to candidates who complete satisfactorily eight units of work after completing an applied psychology undergraduate major at the University of Illinois.

The Doctor of Psychology is awarded in clinical and counseling psychology when the following requirements have been completed: (1) three years of full-time course work consisting of twenty-four to twenty-eight units, of which twenty units must be at the 400 level; (2) one summer session of orientation in a hospital or clinic plus one summer session of practicum in a hospital or clinic; (3) a preliminary examination administered by a committee appointed by the Dean of the Graduate College; (4) one year of internship following the third year of course work; (5) a report on the year of internship (not a dissertation); (6) a final examination administered by a committee appointed by the Dean of the Graduate College.

TRAINEESHIPS

United States Public Health Service Traineeships in Child, Measurement, and Clinical Psychology. Graduate students, including first-year applicants, are automatically considered for these appointments. No application is necessary. Current stipends (tax-free) are: Level I, $1,800; Level II, $2,000; Level III, $2,400; Level IV, $3,000. The trainee has no duties other than full-time graduate work.

Veterans Administration Traineeships in Clinical and in Counseling Psychology. First-year students are not eligible for these appointments. Applicants for advanced standing may apply for a traineeship by a letter addressed to the head of the Department of Psychology. The trainee works approximately half-time in a Veterans Administration hospital as a Civil Service appointee.

Illinois Department of Mental Health Traineeships in Clinical Psychology. First-year traineeships of $1,800 plus exemption from tuition and fees are available to students with special interests in professional clinical work. Advanced traineeships at substantially higher levels of remuneration are also available for students preparing to work as clinical psychologists in the state of Illinois.

GRADUATE FACULTY

Professors: L. G. Humphreys (Head of Department), J. A. Adams, H. W. Ades, W. R. Ashby, W. C. Becker, S. W. Bijou, R. B. Cattell, F. Costin,

D. E. Dulany, C. W. Eriksen, T. N. Ewing, F. E. Fiedler, W. M. Gilbert, G. R. Grice, H. W. Hake, R. Hamlin, J. Hirsch, J. McV. Hunt, W. E. Kappauf, S. A. Kirk, L. H. Lanier, J. E. McGrath, C. S. Moss, O. H. Mowrer, L. I. O'Kelly, C. E. Osgood, D. R. Peterson, H. C. Quay, I. D. Steiner, L. M. Stolurow, M. M. Tatsuoka, H. C. Triandis, L. R Tucker, L. P. Ullmann, J. S. Wiggins.

Associate Professors: R. Anderson, R. S. Bogartz, J. B. Cohen, J. H. Davis, M. E. Fishbein, C. L. Hulin, Alice K. Jonietz, W. E. Montague, G. L. Paul, K. E. Renner, D. T. Shannon, R. L. Sprague, M. Wagman, M. W. Weir, J. S. Werry.

Assistant Professors: L. C. Ate, W. H. Batchelder, G. L. Clore, Jr., L. B. Cohen, N. H. Eisen, F. Fehr, Angela Folsom, G. B. Graen, G. Z. Greenberg, K. T. Hill, L. A. Jakobovits, R. Malpass, W. R. Mead, S. M. Nealey, R. Peterson, R. J. Rose, K. G. Scott, T. Steiner, N. Wiggins.

COURSES FOR GRADUATES

The prerequisites stated apply to graduate majors in psychology. Students minoring in psychology may, by special permission of instructors, enroll in certain of these courses without having met all the prerequisites.

402. **Systematic Psychology.** A critical analysis and comparison of modern and contemporary psychological systems. 1 unit. Prerequisite: Twelve hours of psychology. Dulany.

403. **Proseminar in General Psychology, I.** A brief historical introduction to modern psychology; fundamentals of differential psychology, including the measurement of intelligence, aptitudes, and personality; motivation, emotion, and mechanisms of defense; psychological development; social behavior. 1 unit. Prerequisite: Twelve hours of psychology. Staff.

404. **Proseminar in General Psychology, II.** Sensory processes; perception; fundamental processes in learning; learning theory; special aspects of human learning; language behavior; thinking; logical aspects of psychological theory. 1 unit. Prerequisite: Twelve hours of psychology. Staff.

408. **Design of Experiments in Psychology.** Advanced experimental designs in psychological research; special methods of data analysis. 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Psychology 307. Kappauf.

409. **Psychological Scaling.** Same as Sociology 409. Scaling theory and methodology, with emphasis upon measurement in psychophysics, differential psychology, and social psychology. 1 unit. Offered in 1968-1969 and in alternate years. Prerequisite: Psychology 307. Batchelder, Tatsuoka, Tucker.

411. **Advanced Physiological Psychology.** Detailed examination of the physiological mechanisms in behavior. Research methodology and contemporary literature in the physiology of motivation; learning, perception, and emotion are emphasized. Laboratory demonstrations and problems. 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 311 or equivalent. Mead, O'Kelly.

413. **Computer Applications in Social Statistical Research.** Same as Computer Science and Sociology 413. Computer procedures for the analysis of sociological and psychological data, including probability matrices, dominance matrices, clique analysis, regression analysis, analysis of variance and covariance, canonical correlations, discriminant analysis, and factor analysis. 1 unit. Prerequisite: Sociology 387 or equivalent in statistics; may be taken concurrently with Sociology 387. Dickman.

414. Experimental Personality Research. A laboratory training course emphasizing physiological, perceptual, learning, and genetic approaches to the experimental study of personality. Critical surveys of recent research literature are combined with laboratory training in representative techniques. 1 unit. Prerequisite: Psychology 307 and 404; consent of instructor.

415. Experimental Sensory Psychology. A systematic study of sensory processes, including vision, audition, gustation, olfaction, and somesthesis. Experimental methods, research findings, and theory are emphasized. 1 unit. Prerequisite: Twelve hours of psychology, including a laboratory course in experimental psychology. GREENBERG, KAPPAUF.

416. Perception. Systematic study of methods and research findings in the field of human perception, together with an evaluation of theoretical interpretations. 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Twelve hours of psychology. HAKE.

417. Experimental Psychology of Learning, I: Basic Processes. A study of experimental investigation of basic learning processes, with emphasis upon the nature of the problems, experimental procedures, and theoretical significance. 1 unit. Prerequisite: Twelve hours of psychology. GRICE.

418. Experimental Psychology of Learning, II: Human Learning. Investigation and theory related to perceptual, motor, and verbal learning; retention and forgetting; transfer of training; mediational processes; reasoning. 1 unit. Prerequisite: Psychology 417 or consent of instructor. ADAMS.

419. Advanced Comparative Psychology. A critical survey of techniques, results, and problems in the study of animal behavior and human behavior from the comparative-evolutionary point of view. Laboratory demonstrations and individual research problems. 1 unit. Prerequisite: Twelve hours of psychology or biology. HIRSCH.

421. Problems in Motivation. 1 unit. Prerequisite: Twelve hours of psychology. O'KELLY.

425. Psycholinguistics. Same as Communications and Linguistics 425. A critical survey of methods and theories in the psychological study of the communication process, with emphasis upon linguistic, information-theory and learning-theory approaches, psycholinguistic analysis of language decoding and encoding, and the development and measurement of symbolic processes, including meaning. 1 unit. Prerequisite: Consent of instructor. OSGOOD.

426. Research Seminar in Psycholinguistics. Same as Communications and Linguistics 426. Critical discussion of research problems to which psycholinguistic theories and techniques can be applied. Students taking this course plan, execute, and report an original piece of research in this area. ½ or 1 unit. Prerequisite: Psychology 425; consent of instructor. OSGOOD.

427. Engineering Psychology. Experimental psychology applied to the study of man-machine interrelationships; psychological factors in the design of communication and control equipment. 1 unit. Prerequisite: A laboratory course in experimental psychology or equivalent. HAKE.

428. Higher Process. An examination of method, theory, and research in the study of thinking; status of cognition as a construct; verbal control of behavior; concepts, problem solving, attention, language and thought; cognitive process as a source of motivation. 1 unit. Prerequisite: Twelve hours of psychology, including a laboratory course in experimental psychology. DULANY.

429. Second Language Acquisition and Bilingualism. An examination of the field from a psycholinguistic perspective. The following topics are discussed: first vs. second language acquisition, the nature of language aptitude and competence,

methods of second language teaching, the nature of bilingualism, and comparative psycholinguistics. 1 unit. Prerequisite: Consent of instructor. JAKOBOVITS.

431. **Psychological Measurement in Industry.** Application of psychometric methods and the findings of differential psychology to the selection, classification, and performance evaluation of industrial personnel. 1 unit. Prerequisite: Psychology 307 or equivalent. HULIN.

435. **Motivation and Morale in Industry.** Same as Labor and Industrial Relations 435. Concepts and methods in the study of motivation of employees; determinants of employee attitudes and job satisfaction; modification of attitudes and morale. 1 unit. Prerequisite: Four units of graduate credit in psychology or consent of instructor. NEALEY, TRIANDIS.

441. **Personality and Behavior Dynamics.** The cross-sectional structure of personality, the basic principles of behavior dynamics and the determinants which shape personality development are described. Special topics include typologies, trait measurement, conflict and anxiety, and mechanisms of defense. ½ unit; graduate credit is not allowed for both Psychology 350 and 441. Prerequisite: Twelve hours of psychology. CLORE, WIGGINS.

442. **Behavior Disorders.** A review of the experimental-clinical literature concerning the behavior disorders, with special reference to their classification and etiology. ½ unit. Prerequisite: Psychology 338; consent of instructor. PAUL.

443. **Psychodiagnostics, I.** Instruction and practice in the administration and interpretation of individual tests of general intelligence, special abilities, and achievement. 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 390 or equivalent. SHANNON.

444. **Psychodiagnostics, II.** Instruction and practice in the administration and interpretation of tests and other instruments used in the assessment of personality, with special emphasis upon projective techniques. 1 unit. Prerequisite: Psychology 443; consent of instructor. SHANNON, WIGGINS.

445. **Behavior Modification.** A critical survey of issues, principles, practice, and research related to modifying human behavior. The course covers psychotherapeutic and somatic approaches; symptomatic relief and personality-restructuring goal-orientations; individual, family, group, milieu, and preventive community intervention. ½ unit. Prerequisite: Psychology 444. Registration in Psychology 447 is strongly recommended. ULLMANN.

446. **Laboratory in Behavior Modification.** Practice in techniques of behavior modification with a focus on recent innovations. Research implications of the newer methods are examined. Small sections of the course are formed according to the specialized interests of students and staff. ½ unit. Prerequisite: Psychology 445.

447. **Practicum.** Supervised practice in the assessment and modification of problem behavior. ½ unit. A student may reregister for a maximum of one unit. Prerequisite: Credit or registration in Psychology 445 and 446. SHANNON.

456. **Psychology of Social Communication.** Same as Communications 456. Recent developments in method and theory of attitude change through communication; the nature and determinants of informal social communication; the effects of persuasive communications on public opinion; change in intergroup attitudes through communication. 1 unit. Prerequisite: Psychology 351 or equivalent, or consent of instructor. FISHBEIN.

458. **Group Dynamics.** A critical review of theory, research, and practice related to group behavior, including factors influencing communication, decision-making, group cohesiveness, and productivity. 1 unit. Offered in 1968-1969 and in alternate years. Prerequisite: Six units of graduate credit in psychology including Psychology 351 or equivalent. I. STEINER.

459. **Leadership and Group Effectiveness.** Theories of leadership, methodology in research on leadership; leadership and morale; group structure and group productivity; selection and training of leaders; assembling effective groups. 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Psychology 351 or equivalent. FIEDLER.

460. **Motivation and Personality Development in Children.** Theory, method, and research on the interaction of motivational personality, and learning processes and development in children, with emphasis on experimental studies and a social learning theory approach. Class projects involve some laboratory work with children. 1 unit. Prerequisite: Twelve hours of psychology; consent of instructor.

462. **Human Abilities.** Analysis of individual differences in human abilities, including historical background, measurement methodology, and functional correlates of abilities. The use of ability measures in both experimental and applied research is considered. 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Psychology 307 or equivalent. HUMPHREYS.

463. **Research Methods in Clinical Psychology and Personality.** The logical analysis of clinical inferences and their role in research; problems and methods in the investigation of the development, dynamics, and structure of personality; research in psychotherapy. ½ unit. Prerequisite: Psychology 306 and 403. ERIKSEN, J. S. WIGGINS.

465. **Learning in Children.** An examination of laboratory investigations of children's learning, with emphasis on developmental changes as related to current theories of learning and development. Class projects involve some laboratory work with children. 1 unit. Prerequisite: Twelve hours of psychology; consent of instructor. WEIR.

467. **Personality Assessment.** Methods and theory in the quantitative assessment of personality; review of research findings and trends. 1 unit. Offered in 1968-1969 and in alternate years. Prerequisite: Psychology 307 or equivalent. WIGGINS.

468. **Contemporary Behavior Theory.** An introduction to modern attempts to formulate scientific theories of behavior, with special emphasis on theories concerning the learning process, including the work of Hull, Tolman, and Guthrie. 1 unit. Prerequisite: Six units of graduate credit in psychology; consent of instructor. GRICE.

469. **Cognitive Development.** An examination of laboratory investigations of cognitive development in children, with emphasis on current theories of cognition and language. Class projects involve some laboratory work with children. 1 unit. Prerequisite: Twelve hours of psychology; consent of instructor. L. COHEN.

470. **Principles and Methods of Teaching Psychology.** Designed for graduate students in psychology. Among the major areas considered are: developing course objectives and content; developing and presenting teaching-learning situations; evaluating the attainment of course objectives; advising and counseling students; ethics in teaching; research problems on the teaching of psychology. ½ or 1 unit. Prerequisite: Second-year graduate standing in psychology or consent of instructor. COSTIN.

483. **Psychology of Speech and Hearing Disorders, I.** Same as Speech 483. A survey of psychological techniques utilized in the clinical and experimental study of speech and hearing disorders, with special reference to speech disorders. Review of research findings and development of experimental designs. 1 unit. Prerequisite: Consent of instructor. O'NEILL.

484. **Psychology of Speech and Hearing Disorders, II.** Same as Speech 484. A survey of psychological techniques utilized in the clinical and experimental study of speech and hearing disorders, with special reference to hearing disorders. Review

of research findings and development of experimental designs. 1 unit. Prerequisite: Consent of instructor. O'Neill.

485. **The Sampling of Human Populations and Social Organizations.** Same as Sociology 485. This course covers procedures for selecting samples from and estimating population parameters for human populations and social organizations. The types of sample designs treated include simple random samples—stratified and cluster samples together with random number and systematic selection techniques. Emphasis is given to the study of various kinds of advanced sample designs for both area and institutional settings together with the problems involved in the application of analytical statistics to complicated sampling procedures. Each student is required to participate in a field project which involves the actual selection of a cluster sample from the local area. 1 unit. Prerequisite: Sociology 387 or Economics 371, or consent of instructor.

490. **Individual Research.** For graduate students who wish to conduct research on special problems not included in graduate theses. ½ to 2 units. Prerequisite: Consent of instructor. Staff.

492. **Psychology of Learning and Instruction.** Same as Educational Psychology 492. An advanced course in the nature and conditions of long-term cognitive learning and retention in classroom and similar situations. This course is intended for doctoral students with a special interest in research leading to the improvement of classroom teaching and learning, in psychological aspects of curriculum research, and in the cognitive aspects of military and industrial training. 1 unit. Prerequisite: Consent of instructor. Anderson.

494. **Multivariate Analysis in Psychology and Education.** Same as Educational Psychology and Sociology 494. The principal methods of descriptive statistics used in the analysis of multiple measurements, with emphasis on conventional procedures of factor analysis; profile similarity models; discriminatory analysis; multidimensional scaling. 1 unit. Prerequisite: Psychology 307 or Education Psychology 496; consent of instructor. Tatsuoka, Tucker.

495. **Theory of Measurement.** Same as Educational Psychology 495. Logical and mathematical principles underlying test design, construction, and validation, with particular emphasis on evaluating reliability of measurement, utility resulting from test-based decisions, and validity of descriptions of individuals. 1 unit. Prerequisite: Educational Psychology 496 or Psychology 307, or equivalent; Educational Psychology 392 or Psychology 390, or equivalent. Hastings, Tucker.

499. **Thesis Research.** 0 to 4 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

306. **Quantitative Methods, I.** A lecture and laboratory course in the development and application of quantitative methods in psychological research. 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 135 or equivalent. Batchelder, Kappauf, Tatsuoka.

307. **Quantitative Methods, II.** Continuation of Psychology 306. 1 unit. Prerequisite: Psychology 306. Batchelder, Kappauf, Tatsuoka.

311. **Laboratory in Physiological Psychology.** Research on classical and current problems, with emphasis on the nervous and endocrine systems in information processing and in the regulation of behavioral adaptation, with examples from sensation, perception, motivation, emotion, and learning. Laboratory. ½ or 1 unit. Prerequisite: Psychology 211. Mead.

323. **The Small Social Group.** Same as Sociology 323. Theory, observation, and analysis of face-to-face social groups, such as friendships, cliques, clubs, committees, and laboratory and experimental groups. Deals with the characteristics,

functions, and forms of interaction of small groups and covers recent theoretical and empirical developments in this field of sociology. ½ or 1 unit. Prerequisite: Sociology or Psychology 201.

326. **Motivation and Emotion.** The nature and development of emotion, attitude, motive, and the role of these processes in social adjustment. ½ or 1 unit. Prerequisite: Six hours of psychology. J. COHEN, O'KELLY.

330. **Experimental Psychology, I.** A survey of problems, experimental methods, and research findings in the fields of psychophysics, sensory processes, perception, judgment, and thinking. ½ unit. Prerequisite: Psychology 230 and 235. GREENBERG, HAKE.

331. **Experimental Psychology, II.** A survey of problems, experimental methods, and research findings in the fields of motivation, learning, retention, and work. ½ unit. Prerequisite: Psychology 235 and 248. GRICE, MONTAGUE.

332. **Research Methods in Social Psychology.** Same as Sociology 332. A lecture and laboratory course in the methods and techniques of social psychological research. Emphasis is given to methods for laboratory experiments on small groups. ½ or 1 unit. Prerequisite: Psychology 201 or Sociology 201; Psychology 235 or Sociology 184 and 185. FISHBEIN, MCGRATH.

335. **Mathematical Formulations in Psychological Theory.** Mathematical formulations are illustrated by studying quantitative treatments of various psychological processes. Emphasis is on learning theory, psychophysical laws, and other selected topics. Simple mathematical tools are developed as required. ½ or 1 unit. Prerequisite: Elementary statistics or probability, elementary calculus, and six hours of psychology, or consent of instructor. BATCHELDER, T. STEINER.

338. **Abnormal Psychology.** An introduction for preprofessional students to the psychological aspects of the behavior disorders, including study of the insanities, psychoneuroses, mental deficiencies, and other conditions. ½ or 1 unit. Prerequisite: Six hours of psychology. PETERSON.

345. **Comparative Psychology.** Animal behavior with particular reference to the behavior of vertebrates. ½ or 1 unit. Prerequisite: Six hours of psychology, or Psychology 100 or 103 and one course in zoology. HIRSCH, MEAD.

346. **Behavior Genetics.** Examination of the relations between genetic mechanisms, population structure, and individual differences in behavior; survey of research and possible extensions of research on the genetics of behavior; laboratory work on techniques of behavior study and genetic analysis. ½ or 1 unit. Prerequisite: Psychology 100 or 103; a course in statistics. HIRSCH.

348. **Theories of Learning.** A survey of the basic theories and approaches to theory construction in learning. ½ or 1 unit. Prerequisite: Psychology 248 or Educational Psychology 211. BATCHELDER, T. STEINER.

350. **Research and Theory in Personality.** The study of personality for the advanced student in psychology; the problems of measurement, development, structure, dynamics, and change of personality are considered; examples of current theory and research are studied as illustrations of an objective approach to the field. ½ or 1 unit. Prerequisite: Psychology 100 or 103; Psychology 235 or equivalent.

351. **Advanced Social Psychology.** Same as Communications and Sociology 351. An integrative treatment of individual behavior variables in relation to group variables. ½ or 1 unit. Prerequisite: Psychology or Sociology 201; Psychology 235, or Sociology 385, or a comparable statistics course. MCGRATH, I. STEINER.

352. **Attitude Theory and Measurement.** Same as Communications and Sociology 352. A comprehensive survey of psychological theories of attitude organization and change, and a theoretical and methodological analysis of the various tech-

niques used to measure attitude. Theories and methods are evaluated with respect to empirical research in the area. ½ or 1 unit. Prerequisite: Sociology or Psychology 201; a course in statistics. FISHBEIN.

355. **Industrial Social Psychology.** Same as Labor and Industrial Relations 355. Social psychological research and theory applied to industrial problems. Emphasis upon interaction and communication theory, role theory, leadership theory, motivational and perceptual theory, and group structure theory as an aid in understanding and analyzing industrial problems. ½ or 1 unit. Prerequisite: Psychology 201 or 357. TRIANDIS.

356. **Human Factors in Equipment Design.** The contributions of psychological research to the design of equipment for efficient human use and operation. Studies of the characteristics and limitations of the human individual which bear upon the equipment and machines best suited to his use. A survey of research on visual and auditory displays, controls, layout of consoles; complex man-machine systems; vigilance and isolation effects; design for efficient trouble-shooting and maintenance. Emphasis is placed upon the methods used in collecting data on these problems. Applications to engineering, industrial design, management, etc., are discussed. ½ or 1 unit. Prerequisite: Psychology 100 or 103; one course in statistics or college mathematics. GREENBERG.

357. **Psychology of Industrial Conflict.** Same as Labor and Industrial Relations 357. An analysis, in terms of behavior of individuals, of the causes and possible solutions of industrial conflict. ½ or 1 unit. Prerequisite: Psychology 100 or equivalent. Offered in special interest of industrial relations, commerce, and engineering students. HULIN, NEALEY.

358. **Human Performance in Man-Machine Systems.** Examination of equipment and training variables that influence the human operator and the effectiveness of man-machine systems; methods of task analysis for the systematic determination of behavioral requirements; design and use of simulators and other training devices; measurement of operator proficiency; control and display variables in closed-loop tracking systems; motor and perceptual fatigue; effect of work load; contemporary issues. Field trips. Research project on equipment design. ½ or 1 unit. Prerequisite: Psychology 100 or 103; one course in statistics or college mathematics. ADAMS.

359. **The Social Psychology of Organization.** Same as Sociology 359. Analysis of the interrelationships between social and psychological factors on the one hand and organizational structure and process on the other; emphasis on sources, consequences, and modes of resolution of intra-individual, intra-organizational, and inter-organizational conflict. 1 unit. Prerequisite: Psychology 355 or Sociology 322. MCGRATH.

360. **Modern Viewpoints in Psychology.** A brief survey of early theoretical psychology followed by an examination of contemporary "behavior theory," Gestalt theory, and psychoanalytic theory—as conceptions of man and as approaches to the study of learning, perception, personality, and social behavior. ½ or 1 unit. Prerequisite: Nine hours of psychology with an average grade of B, or consent of instructor. DULANY.

361. **Advanced Developmental Psychology.** Theory and research on psychological development from birth through adolescence; maturation of behavior systems; the role of social learning in development; the effects of early experience on personality development; critical stages in development. 1 unit. Prerequisite: Psychology 216, 217; a course in statistics. HUNT, SCOTT.

371. **Psychological Factors in Political Behavior.** An application of psychological methods and theories to the study of political behavior. Special attention is given to research methods and to content problems in voting behavior and national

security policy. ½ or 1 unit. Prerequisite: Six hours beyond 100-level courses in psychology, political science, or sociology.

373. **Human Development in Cross-Cultural Perspective.** Same as Anthropology 373. The comparative analysis of recurrent problems inherent in the biosocial nature of man, particularly as these are reflected in stages of the life cycle from birth through death. Attention is also given to the cross-cultural study of other selected topics such as illness and health, deviancy, and the handling of aggression. Use is made of materials available on the campus in the Human Relations Area Files. ½ or 1 unit. Prerequisite: Six hours of anthropology, psychology, or sociology, or consent of instructor. CASAGRANDE.

374. **Problems in Human Ecology.** Same as Anthropology, Geography, Health Education, Physiology, Sociology, and Veterinary Medical Science 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multidisciplinary studies of selected current problems. 1 unit. Prerequisite: Anthropology, Geography, Health Education, Physiology, Sociology, or Zoology 369.

386. **Methods of Field Research.** Same as Sociology 386. Instruction, training, and supervised practice in methods of field research as a basic tool of psychology. Major emphasis is placed on the role of the field researcher as participant, observer, and interviewer in various kinds of research settings, and on approaches to and applications of field data. Each student develops and executes a field research project dealing with some aspect of institutional, occupation, or general community activity and structure. ½ or 1 unit. Prerequisite: Psychology or Sociology 201; Psychology 235 or Sociology 184 and 185.

390. **Psychological Tests and Measurements.** The measurement of human behavior in psychological studies; the construction and use of psychological tests; introduction to tests of intelligence, achievement, personality, and interest; practice in test construction, administration, and validation. Lectures and laboratory. 1 unit. Prerequisite: Psychology 235. HULIN, N. WIGGINS.

RADIO AND TELEVISION

The Department of Radio and Television offers work leading to the Master of Science in Radio and Television and the Master of Television. For the program leading to the Doctor of Philosophy in Communications, see page 124.

Admission to the program leading to the Master of Science requires (1) completion of the requirements for a bachelor's degree in an institution of recognized standing, preferably with a major (normally twenty semester hours) in radio-television or a related field, English, or the social sciences; (2) a grade-point average of at least 3.75. Applications of students with grade-point averages below 3.75 but above 3.5 are considered on an individual basis.

Admission to the program leading to the Master of Television requires (1) meeting minimum requirements for admission to the Graduate College; (2) a bachelor's degree from an accredited institution, ordinarily with a major in radio, television, theatre arts, journalism, or some other area related to television; (3) the approval of an entrance committee.

Master of Science in Radio and Television. Requirements for this degree include: (1) A major of four units or three units and one additional unit approved by the adviser; (2) a minor of at least two units, normally in an area outside the College of Communications; (3) a one unit thesis; (4) a minimum of three units in courses (including thesis) at the 400 level, at least two of which must be in the major field; (5) a minimum of eight units.

Master of Television. This degree differs from the Master of Science program in

these ways: it does not require a thesis, but instead requires study in special problems of television; it does not require a minor, but permits concentration in the fifth year in the radio and television field.

Requirements for the degree include a total of eight units of credit, with a minimum of six units selected from courses in the television sequence.

A list of the specific courses that must be included in the Master of Science in Radio and Television and the Master of Television degree programs is available upon request from the department.

Students are expected to plan their programs around a special interest area which may include television production and direction, television writing, television news, television advertising, cinematography for television, television art, and television scenic design.

GRADUATE FACULTY

Professors: F. E. Schooley, H. J. Skornia.

Assistant Professor: H. W. Lippold, Jr.

Instructor: B. L. Sims.

COURSES FOR GRADUATES

450. Special Problems in Television. Project work for advanced students in specific areas of television, including news, advertising, directing, writing, etc. 1 to 2 units. Prerequisite: A television course in the area of specialization; consent of instructor. Staff.

451. Television Program Management and Production. Problems in originating, planning, and producing television programs. 1 unit. Prerequisite: Course or experience in television directing and production; consent of instructor.

462. Seminar in Radio and Television. Same as Communications 462. A study of the performance of radio and television in terms of content, government and industry controls, social responsibility, economic bases, and psychological and social effects. 1 unit. Skornia.

463. World Broadcasting. Same as Communications 463. A study of the broadcast systems used by the nations of the world; alternative and "mixed" systems; international organizations, agreements, exchanges, and problems; broadcasts to and from other countries; implications of such new developments as satellites; mass and non-mass uses. 1 unit. Prerequisite: Radio-Television 462 or consent of instructor. Skornia.

490. Special Topics in Radio and Television. ½ or 1 unit. Prerequisite: Consent of head of department. Staff.

499. Thesis Research. 1 to 2 units. Prerequisite: Graduate standing in radio-television. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

354. Television Directing. The theory and techniques of directing the television program. Experience in directing laboratory productions. ½ unit. Prerequisite: Radio-Television 252; consent of instructor.

355. Television News. News coverage, script preparation, use of visual materials, and presentation of news programs. Attention given to interviews, special events, and news fields of special interest. ½ unit. Prerequisite: Consent of instructor. Lippold.

356. Cinematography for Television. The equipment and techniques used in the production of films for television, including camera operation, lighting, editing,

sound recording, matching, etc. Materials cost approximately $50.00. ½ unit. Prerequisite: Consent of instructor. SIMS.

360. Educational Uses of Television and Radio. Same as Communications and Educational Psychology 360. A study of television and radio as educational instruments, and standards necessary for such use; production, utilization, planning, and evaluation; primary and secondary uses. Identification of the unique contributions and resources of the electronic media, as well as their limitations. Experimentation into new production and utilization techniques designed for educational uses. ½ unit. MCINTYRE, SKORNIA.

362. Radio and Television Station Management. A study of the organization and administration of the radio and television staff and station; public relations, personnel management, and station operation; analysis of station and agency relationships and radio and television sales procedure; methods and media for program and station promotion; laws and regulations affecting management, financing, and labor relationships. ½ unit. Prerequisite: Radio-Television 261. SCHOOLEY.

363. Advanced Dramatic Writing. Same as Speech English 363 and Theatre 380. Application of principles of dramatic form and structure to the more complex problems of playwriting. Practice in writing sustained dramatic forms. ½ or 1 unit; students may accumulate 2 units of credit. Prerequisite: Speech 263 or equivalent; consent of instructor. SMALLEY.

365. Radio News. News writing and editing for broadcasting; radio news style; preparation and practice for special event reporting; commentaries and interpretations; radio news services, and processing radio news service copy. ½ unit. Prerequisite: Journalism 211. CRAMER.

366. Advanced Radio and Television Practices, I. Project work for advanced students in selected areas of radio and television, including news, advertising, announcing, production and direction, and writing. ½ unit. Prerequisite: All courses in area of specialization; consent of instructor. STAFF.

367. Advanced Radio and Television Practices, II. Continuation of Radio-Television 366. ½ unit. Prerequisite: All courses in area of specialization; consent of instructor. STAFF.

368. Radio and Television Regulation. Federal legislation, with emphasis on the Communications Act of 1934 and the regulations of the Federal Communications Commission, legal problems in program operation, censorship and editorial selections, copyright, and author-producer relations. ½ unit. SCHOOLEY.

RECREATION AND PARK ADMINISTRATION

The Department of Recreation and Park Administration offers a program of graduate study leading to the Master of Science in Recreation. (For information regarding the degree of Doctor of Philosophy in Physical Education with specialization in recreation, see page 315). This program primarily prepares leaders, supervisors, administrators, teachers, and research workers in community recreation, but it also offers opportunities for preparation in the related fields of park administration, therapeutic recreation and rehabilitation, outdoor recreation, and college union administration, as well as recreation work with private agencies, business and industry, commercial recreation enterprise, etc.

Admission requirements for a major in this field are (1) a minimum grade-point average of 3.5 for the last sixty semester hours; (2) thirty semester hours of approved undergraduate credit in recreation or closely allied courses; (3) fifteen semester hours in the social and psychological sciences; (4) eight semester hours of undergraduate

credit in the natural sciences; and (5) a course in statistics or tests and measurements.

Requirements for this degree are eight units including (1) four units of credit in approved courses to be chosen in the following areas: recreation, education, political science, psychology, social work, and sociology; (2) two units of approved electives to be chosen in the following areas: art, botany, geology, health education, landscape architecture, literature, music, physical education, speech, and zoology; (3) registration in and satisfactory completion of Recreation 490, without credit; (4) presentation of an acceptable thesis in recreation, two units. The thesis requirement may be waived on petition, in which case two additional units of approved credit are required. A final comprehensive written examination in recreation may be required, depending upon the program of courses and accomplishment in seminar and the thesis.

GRADUATE FACULTY

Professors: A. V. Sapora (Head of Department).

Associate Professor: H. E. Weaver.

Assistant Professors: D. W. Bishop, M. Virginia Frye.

COURSES FOR GRADUATES

401. **Foundations of Recreation.** Basic philosophical, historical, and scientific foundations and developments in leisure and recreation; analysis of recreation values as related to other contemporary individual and community needs; functions and settings of organized recreation, special problem areas, and current issues. 1 unit. Prerequisite: Recreation 176 or equivalent.

402. **Recreation Administration.** Designed to strengthen the graduate student's knowledge of the public administration of recreation programs and services provided by municipal, county, state, and national departments and agencies and as related to the general well-being of individuals, families, and communities. 1 unit. Prerequisite: Basic courses in the organization of recreation, or equivalent.

403. **Evaluation of Recreation Resources and Programs.** Methods and techniques of determining recreational needs, interests, and opportunities of individuals and communities through surveys, studies, and appraisals; evaluating and appraising community recreation programs and services; research in the field of recreation. 1 unit. Prerequisite: Recreation 176 or 375, or equivalent; a course in tests and measurements or statistics. Sapora.

404. **Outdoor Education and Recreation.** Philosophy, essential principles, methods, techniques, resources, administrative and program practices for outdoor education and recreation. 1 unit. Prerequisite: Recreation 174 or equivalent; one undergraduate course in biology, botany, geology, or zoology. Weaver.

490. **Seminar.** Student presentation of thesis studies, informal discussions, and critical analysis of problems; informal lectures by invited speakers. No credit. Staff.

493. **Special Projects.** Independent research on special projects. Open only to students majoring in recreation. ½ to 2 units. Prerequisite: Recreation 403 or equivalent. Staff.

499. **Thesis Research.** Preparation of thesis in recreation. 0 to 4 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

375. **Introduction to Administration.** Organization of public and private agency programs, leadership, facilities and services; introduction to recreation administration. ½ or 1 unit. Prerequisite: Recreation 176. Johns, Sapora.

385. **Park Management.** An intensive study of the principles, practices, and problems involved in managing public park systems. Designed to provide a professional

background including the history of parks, organization, planning, examination of facility design and layout, maintenance, finance, and operation of park systems. ½ or 1 unit. Prerequisite: Landscape Architecture 226, Urban Planning 171, Political Science 305, Recreation 278 and 279, or equivalent. JOHNS, OWENS.

390. Principles of Therapeutic Recreation. Concepts, principles, objectives, methods, and settings of recreation for the ill and handicapped. ½ or 1 unit. Prerequisite: Recreation 176 and 208 or 209, or consent of instructor. FRYE.

395. Recreational Use of Public Lands. A study of lands in the public domain, and their historical, current, and potential use for outdoor recreation. It includes an analysis of land, woods, and water in the public domain; the demand for outdoor recreation; multiple use concept of natural resources; functions and policies of federal and state governments and their agencies; the economics of outdoor recreation; and the future of outdoor recreation in America. ½ or 1 unit. Prerequisite: Recreation 176, Geography 214, and Economics 108, or consent of instructor.

RUSSIAN LANGUAGE AND AREA STUDIES

Graduate programs in Russian language and area studies are offered by the Center for Russian Language and Area Studies in cooperation with various departments.

Minor for the Master's Degree. A candidate for the master's degree who elects Russian language and area studies as a minor must earn at least two units of graduate credit in courses chosen from the following: anthropology, economics, geography, history, law, library science, political science, Russian, and sociology. The courses chosen must be in at least two departments.

Minor for the Doctor of Philosophy Degree. A doctoral candidate who elects Russian language and area studies as a minor must demonstrate a reading command of Russian as tested by examination or by completion of Russian 104 or 401 with a grade of A or B, and in addition must earn at least four units of graduate credit in courses chosen from the list given just above. The four units must include courses from at least two departments outside of, and may at the same time include up to one unit from within, the department offering the candidate's major.

Certificate of Graduate Specialization in Russian Language and Area Studies. This certificate is awarded by the Graduate College and the Center for Russian Language and Area Studies. It is for persons with the baccalaureate who are enrolled in advanced studies in any discipline and who wish at the same time to gain a knowledge of the Russian area and language. The requirements are: (1) A good command of written and spoken Russian, as determined by special examinations, or a grade of A or B in Russian 104 or 401. (2) At least six graduate units relating to Russia, distributed among at least three of the departments represented in the program (anthropology, economics, geography, history, law, library science, political science, Russian, and sociology) other than the student's own major department. If the student's major department is one of these nine he may count, as part of his six units, up to one unit from within his major department. (3) A special essay based largely on Russian sources, which must meet, at the minimum, the standard normally required in a master's thesis. The student may submit, in fulfillment of this requirement, a copy of his master's thesis or doctoral dissertation.

The adviser for the graduate minors and the Certificate is Professor Ralph T. Fisher, Jr., Director of the Center for Russian Language and Area Studies, 1207 West Oregon Street, Urbana.

GRADUATE FACULTY

Professors: R. T. FISHER, JR. (Director of the Center for Russian Language and

Area Studies), C. L. Dawson, J. D. Fellmann, D. R. Hodgman, E. G. Lewis, Temira Pachmuss, D. B. Shimkin, A. Vucinish.

Associate Professors: E. C. Bristol, K. A. Hitchins, K. Klein, P. B. Maggs.

Assistant Professors: M. A. Curran, R. Dunatov, F. Y. Gladney, S. P. Hill, T. M. Lightner, J. R. Millar, L. H. Miller, B. Uroff.

SLAVIC LANGUAGES AND LITERATURES

(Including Russian, Slavic, and Ukrainian)

The Department of Slavic Languages and Literatures offers graduate work leading to the Master of Arts in Russian, Master of Arts in the Teaching of Russian, and Doctor of Philosophy in Russian.

Students with a minimum grade-point average of 4.0 are regularly admitted to graduate courses, subject to fulfillment of other prerequisites. Students with a grade-point average between 3.5 and 3.99 are admitted upon approval of the department.

Students electing Russian as a major subject should have had the equivalent of at least four years of Russian in college, including practical work in the use of the language and an advanced course in literature.

Students choosing Russian as a minor subject should consult the department.

Master of Arts in Russian. In addition to fulfilling the general requirements of the Graduate College, candidates must pass both a written and an oral examination. Students may major in literature or linguistics and may offer a minor. Students majoring in literature must present at least two courses in linguistics; those majoring in linguistics must present at least two courses in literature.

Master of Arts in the Teaching of Russian. Candidates for this degree are required to take: (1) Russian, five units: up to three units from 300-level courses and at least two units from courses open only to graduates; (2) education, two units including Educational Psychology 311 and 312 and two of the following: History and Philosophy of Education 303, 304, 305; (3) electives, one unit. These courses must be selected with the approval of the adviser. Candidates must pass an examination based on their course work and on a reading list. See pages 45 and 46.

Doctor of Philosophy in Russian. All candidates for this degree must fulfill the general requirements of the Graduate College and must have a reading knowledge of French and German. A student may major in literature or linguistics, but must offer a minor, preferably in another language or literature, comparative literature, or linguistics. Those students majoring in literature must present at least four courses in linguistics, as well as training in another Slavic language; students majoring in linguistics must present at least four courses in literature, along with some training in two other Slavic languages.

GRADUATE FACULTY

Professor: C. L. Dawson (Head of Department).

Associate Professors: Evelyn Bristol, K. Klein, Temira Pachmuss.

Assistant Professors: R. Dunatov, F. Y. Gladney, S. P. Hill, T. M. Lightner.

Russian

COURSES FOR GRADUATES

400. **Beginning Russian for Graduate Students.** Basic grammar and vocabulary, introduction to the reading of Russian texts in the sciences and the humanities.

Designed for graduate students preparing to offer a reading knowledge of Russian for the Ph.D. No credit.

401. **Readings in Russian for Graduate Students.** Reading and translation of general and individually specialized materials, to increase speed, accuracy, and vocabulary. Designed for graduate students preparing to offer a reading knowledge of Russian for the Ph.D. No credit. Prerequisite: Russian 400 or equivalent.

406. **Russian Morphology.** A survey of the various parts of speech of modern standard literary Russian with special emphasis on the nominal and verbal systems. 1 unit.

407. **Russian Syntax.** A survey of historical and contemporary Russian syntax. 1 unit. Prerequisite: Consent of instructor or head of department.

408. **Russian Phonology.** Same as Linguistics 408. Synchronic examination of the phonological system of modern Russian and of its interrelation with the syntactic and lexical systems; brief discussion of the historical development of the phonological system. 1 unit. Prerequisite: Consent of instructor.

410. **Literature of the Eleventh to the Sixteenth Century.** Reading of texts. Historical and literary background of the period. 1 unit. Prerequisite: Consent of instructor or head of department.

412. **Literature of the Seventeenth and Eighteenth Centuries.** Reading of texts. Historical and literary background of the period. 1 unit.

414. **Pushkin.** The age of Pushkin; Pushkin's works in historical and comparative perspective; textual criticism, linguistic and structural analysis, intellectual interpretation, and aesthetic evaluation. 1 unit. Prerequisite: Consent of instructor or head of department.

415. **Dostoevsky.** Dostoevsky: historical background, textual analysis, structure, philosophy and ideology, and aesthetic evaluation. 1 unit. Prerequisite: Consent of instructor or head of department.

416. **Studies in Russian Criticism.** 1 unit. Prerequisite: Consent of instructor or head of department.

417. **History of the Russian Language.** 1 unit. Prerequisite: Slavic 405.

419. **Tolstoy.** Tolstoy: historical background, textual analysis, structure, philosophy and ideology, and aesthetic evaluation. 1 unit. Prerequisite: Consent of instructor or head of department.

420. **Chekhov.** Chekhov: historical background, textual criticism, structural analysis, philosophy and ideology, and aesthetic evaluation. 1 unit. Prerequisite: Consent of instructor or head of department.

421. **Seminar in the Russian Novel.** Dostoevsky, Tolstoy, nineteenth-century novel, twentieth-century novel. 1 unit. May be repeated for a total of three units. Prerequisite: Consent of instructor or head of department.

422. **Russian Literature in Exile.** Bunin, Merezhkovsky, Kuprin, Zaitsev, Remizov, Teffi, Aldanov, Shmelev, Z. Hippius, V. Ivanov, Xodasevich, Tsvetaeva, Varshavsky, Odoevtseva, G. Ivanov, Adamovich—prose writers, poets, and critics. 1 unit.

423. **Seminar in Russian Poetry.** Pushkin, narrative verse, lyric verse, symbolism. Course may be repeated for credit not to exceed three units. 1 unit. Prerequisite: Consent of instructor or head of department.

425. **Seminar in Russian Drama.** Intensive analysis and discussion of specific genres, periods, and dramatists in the light of dramatic theories. The subject of the course varies each year. 1 unit. May be repeated for a maximum of 3 units credit. Prerequisite: Consent of instructor or head of department.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. **Russian Phonetics and Pronunciation.** Study of the Russian sound system; training in the improvement of pronunciation and intonation. ¾ unit. Prequisite: Russian 212 or consent of instructor.

311. **Advanced Russian Conversation.** Practice in free conversation with a native speaker. ¼ unit. Prerequisite: Three years of college Russian, including Russian 211 and 212, or consent of instructor.

312. **Soviet Literature in Translation.** Survey of Russian literature since the 1917 Revolution; cultural and historical background of the period. No knowledge of the Russian language is required. ½ unit.

313. **Advanced Russian Composition.** Practice in advanced composition and study of advanced problems of grammar, syntax, and style. ¼ unit. Prerequisite: Three years of college Russian, including Russian 213 and 214, or consent of instructor.

321. **Russian Literature from 1810 to 1845.** Representative works of the period, with emphasis on Pushkin, Lermontov, and Gogol. ¾ unit. Prerequisite: Russian 201 and 202, or consent of instructor.

322. **Dostoevsky and Tolstoy.** Representative works in their historical and cultural contexts. ¾ unit. Prerequisite: Russian 201 and 202, or consent of instructor.

323. **Russian Literature from 1845 to 1880.** Representative works of the period, with emphasis on Turgenev, Goncharov, and Ostrovsky. ¾ unit. Prerequisite: Russian 201 and 202, or consent of instructor.

324. **Russian Literature from 1880 to 1917.** Representative works of the period, with emphasis on Chekhov, Gorky, and Blok. ¾ unit. Prerequisite: Russian 201 and 202, or consent of instructor.

325. **Soviet Russian Literature.** Representative works of Russian literature since 1917: Mayakovsky, Leonov, Sholokhov, and others; historical and cultural backgrounds. ¾ unit. Prerequisite: Russian 202 or consent of instructor.

326. **Masterpieces of Russian Literature.** Masterpieces of Russian literature: historic background, textual analysis, structure, philosophy and ideology, aesthetic evaluation. This course is designed primarily for students in teacher training programs. ¾ unit. Prerequisite: Russian 201 and 202.

332. **Traditions of Russian Literature and Thought.** The rise and development of Russian social and philosophical thought in the nineteenth century and its impact on literature. ¾ unit. Prerequisite: Consent of instructor.

333. **The Russian Short Novel.** Theory and techniques of the *povest'* and related forms in the nineteenth and twentieth centuries. S; ½ unit. Prerequisite: Russian 201 and 202, or consent of instructor.

Slavic

COURSES FOR GRADUATES

405. **Old Church Slavonic.** Analysis of grammar, reading of texts, discussion of development of the Slavic languages. 1 unit. Prerequisite: Slavic 380.

418. **Oral Poetry and Slavic Poetics.** Linguistic material and poetic form. Oral poetry in its genres, motifs, and themes; their unit and diversity in the cultural history of Slavic peoples; the impact of oral poetry on literary tradition. 1 unit.

460. **Comparative Slavic Phonology.** The phonological structure of Common Slavic at the time of dissolution of the primitive Slavic community; the characteristic tendencies in the evolution of sound and prosodic systems in the East, West, and

South Slavic language groups; the phonemic patterns of single modern Slavic languages outlined as a basis for a typological classification of Slavic languages. 1 unit. Prerequisite: Slavic 380.

461. Comparative Slavic Morphology. A lecture course designed to trace the development of the principal parts of speech, their various inflectional and derivational morphemes and their attendant grammatical categories from Common Slavic to the various modern Slavic languages, and to make comparisons among the modern synchronic morphological treatments of these languages. 1 unit. Prerequisite: Slavic 460.

491. Individual Topics. ¼ to 2 units. Prerequisite: Graduate standing with a major or minor in Russian.

499. Thesis Research. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

331. Slavic Civilization and Literatures. A survey of Slavic institutions and life as reflected in Slavic literatures other than Russian (Polish, Czech, Ukrainian, etc.) and their connection with Russian traditions. ¾ unit. Prerequisite: Reading knowledge of Russian or one other Slavic language, or consent of instructor.

380. Introduction to Slavic Linguistics. Same as Linguistics 380. Changes in phonology and morphology from Indo-European to Common Slavic; geographical distribution of Slavic languages and dialects, prehistory and early history of the Slavs, and Balto-Slavic linguistic relationships. ¾ unit.

382. Language Laboratory Techniques. Same as French, German, and Spanish 382. Instruction and practice in the techniques of making foreign-language tapes and integrating them with classroom activity; instruction in the problems of planning and operating a language laboratory. S; ½ unit. Prerequisite: Three years of a modern foreign language at the college level, or equivalent.

Ukrainian

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

396. The Structure of Ukrainian. Ukrainian phonology, morphology, and syntax presented with Russian as a background and basis for comparison of these two East Slavic languages. ¾ unit. Prerequisite: Russian 104 or equivalent.

398. Readings in Ukrainian Literature. Representative works of Ukrainian literature and their historical and cultural background. ¾ unit. Prerequisite: Ukranian 396 or consent of instructor.

SOCIAL SCIENCES

Master of Arts in the Social Sciences. A special program leading to the Master of Arts in the Social Sciences is offered to students through the Division of Social Sciences (including anthropology, economics, geography, history, philosophy, political science, psychology, social work, and sociology). This program is designed to meet the needs of students who plan to teach the social sciences and the needs of those who wish to study in several related fields within the social sciences rather than to specialize in one department. To qualify for this program a student must have a grade-point average of at least 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

The Master of Arts in the Social Sciences requires a major of four units and a minor or double minor totaling four units. No minor may be less than two units. At

least three of the eight units required for this degree must be in 400 level courses, with at least two of these three units in the major. The student's work is directly supervised by an advisory committee, composed of two or three members, one for each field of study forming a major or minor. The representative of the major field is the chairman of the committee. As part of his work in the major field, each student is required to write an essay under the direction of the chairman of the committee and subject to his approval. Work upon this essay may constitute, through registration in research courses, part of the four units of work required for the major. At the completion of his studies the student must pass an oral comprehensive examination given by the committee as a whole.

The Chairman of the Division of Social Sciences is Professor John Thompson, 222 Davenport Hall. The general adviser for this degree is Professor George Manner, 384 Lincoln Hall.

Master of Arts in the Teaching of Social Studies. Candidates for the degree of Master of Arts in the Teaching of Social Studies must earn four units in social studies, three units in education, and one unit in electives. The courses in the social studies should be selected from not more than three of the following fields: history (two units required), economics, geography, philosophy, political science, and sociology. The courses in education must include Educational Psychology 311, 312, Secondary and Continuing Education 456, and History and Philosophy of Education 304 and 305. The courses in social studies and the electives must be selected with the approval of the adviser. The electives may be in the social studies, in education, or, in exceptional cases, in other fields. The grade-point average required for admission is 3.75. Applications of students with grade-point averages below 3.75 but above 3.5 are considered on an individual basis. See pages 45 and 46.

The adviser for candidates for this degree is Professor Robert Waller, 315 Armory.

SOCIAL WORK

The Jane Addams Graduate School of Social Work offers two years of graduate professional study leading to the Master of Social Work. Although the basic curriculum of the School is the same for all students, there are opportunities for specialization in casework and group work. Students specializing in group work have their classes on the University of Illinois Chicago Circle campus and field placements in group work agencies in the city. Those specializing in casework may have classes on either the Urbana or Chicago campus, with field placements in selected agencies nearby.

The School has established an admissions committee which is responsible for reviewing all applications. The committee's scrutiny of scholastic achievement is directed principally to the applicant's record in the social sciences and pre-professional social work courses, and in those courses which reveal mastery of the English language. A minimum of twenty hours in social science courses is required. The applicant must give evidence of ability to carry graduate work.

In addition to scholastic achievement, the admissions committee attempts to determine the applicant's personal suitability for professional education in social work. Admission is granted only to the applicant whose health is sufficiently good to permit his undertaking a study program which taxes physical energy. The applicant must also show evidence of emotional maturity commensurate with his age and past experience; interest in and liking for people, and ability to establish harmonious and healthful relationships; and personal integrity as demonstrated by intellectual honesty and a sense of responsibility. Serious deficiencies in these areas disqualify an applicant.

The School is compelled to limit enrollment to the number of field work placements available.

The courses listed on page 354 describe the program offered on the Urbana campus. Similar courses are offered in Chicago under a quarter term calendar, and the

group work sequence is offered only there. For information about the Chicago program, the School's special catalog should be consulted.

Application must be made to the Jane Addams Graduate School of Social Work. The special catalog issued by the School may be obtained by writing to the Director, Jane Addams Graduate School of Social Work, University of Illinois, 1207 West Oregon Street, Urbana 61801.

GRADUATE FACULTY

Professors: M. P. Hale (Director of the Jane Addams Graduate School of Social Work), Jennette R. Gruener, Florence L. Poole, W. P. Simon.

Associate Professors: Lela B. Costin, Margaret G. Holden, D. E. Lathrope, J. E. McDonald, Aleanor R. Merrifield, Mary E. Sullivan, M. A. Taber, L. Jane Wille.

Assistant Professors: J. J. Alderson, Eloise J. Cornelius, S. Mirelowitz, H. Treger.

COURSES FOR GRADUATES

421. Social Casework, I. Analysis and study of philosophy, concepts, principles, and methods of social casework; role of caseworker in offering service; psychological and cultural factors affecting treatment; analysis of relationship, study-diagnosis, and treatment. ½ to 1 unit.

422. Social Casework, II. Casework principles and methods with emphasis on work with clients with complex emotional and personality problems; the stresses which impair social and ego functioning; the effects of agency setting. Casework methods as adapted to treatment of children and their parents, adults, the neurotic and mentally ill, the delinquent; multiple client interviewing and family diagnosis and treatment. ½ to 1 unit. Prerequisite: Social Work 421.

425. Group Process and Method. Small group theory and the group process; the use of group process and methods in social work practice. ½ to 1 unit.

426. Social Planning and Administration. Principles, concepts, and methods of planning and administration of social services; emphasis on leadership, policy and decision making, and program organization. ½ to 1 unit.

427. Social Research. Objectives of social research, design of experiments, and measurement and methods of collecting data; design of questionnaires and schedules; methods of data analysis including statistical hypothesis testing and applications of inferential techniques; interpretation of results; perparation of reports. ½ to 1 unit.

431. Practice Seminar, I. Critical examination of the application of knowledge to social work practice; emphasis on reciprocal relationships between personal problems and needs, social environment, agency services, and helping methods; consideration of new trends in practice and empirical knowledge. 1 unit. Prerequisite: Social Work 422, 425, 426, 452, and 482.

432. Practice Seminar, II. Critical examination of the application of knowledge to social work practice; emphasis on relationships between personal problems, social problems, planning processes, and agency purposes and functions; consideration of trends in social policy and empirical knowledge. 1 unit. Prerequisite: Social Work 423 and 468.

451. Human Growth and Behavior, I. The major forces influencing the growth and behavior of the individual from birth through adulthood; sociocultural, familial, physical, emotional, and intellectual factors as they enhance or retard social functioning; the nature and dynamics of social process as related to growth and behavior; the relevance of this content to social work practice. 1 to 1½ units.

452. **Human Growth and Behavior, II.** Inter-relationship of physical, emotional, and social aspects of selected diseases, and implications for the patient, family, and community; psychopathology, including neuroses, psychoses, character disorders, psychosomatic dysfunction, organic conditions, and mental retardation; diagnosis and treatment methods, including psychotherapy, somatic and drug therapies, and social work. 1 to 1½ units. Prerequisite: Social Work 451.

461. **Special Studies in Social Work, I.** Independent or group study in areas of special interest; application of social work principles to special problems or settings. ½ to 2 units.

462. **Special Studies in Social Work, II.** Independent or group study in areas of special interest; application of social work principles to special problems or settings. ½ to 2 units.

466. **Field Instruction, I.** The student is assigned to field instructors for learning experiences in social agencies and communities. Such experiences include the use of knowledge and understanding in analyses of case and problem situations and in direct service to agency clientele. ½ to 1 unit. Prerequisite: Credit or registration in Social Work 421.

467. **Field Instruction, II.** The student is assigned to field instructors for learning experiences in social agencies and communities. Such experiences include the use of knowledge and understanding in analyses of case and problem situations and in direct service to agency clientele. ½ to 1 unit. Prerequisite: Social Work 421 and 466; credit or registration in Social Work 422.

468. **Field Instruction, III.** The student is assigned to field instructors for learning experiences in social agencies and communities. Such experiences include the use of knowledge and understanding in analyses of case and problem situations and in direct service to agency clientele. 1 to 2 units. Prerequisite: Social Work 422, 466, and 467.

469. **Field Instruction, IV.** The student is assigned to field instructors for learning experiences in social agencies and communities. Such experiences include the use of knowledge and understanding in analyses of case and problem situations and in direct service to agency clientele. 1 to 2 units. Prerequisite: Social Work 422, 466, 467, and 468.

481. **Social Services and Welfare Policy, I.** The function, nature, and scope of the social welfare institution; the social services as a response to social, personal, and economic problems of people; effects of economic and social growth and change on the welfare enterprise; current provisions of money aid programs and services for the aged, children, court wards, and the mentally and physically ill. 1 to 1½ units.

482. **Social Services and Welfare Policy, II.** Critical evaluation of current social services and welfare policy issues and alternatives for their solution; methods of planned change in the resolution of policy issues. ½ to 1 unit. Prerequisite: Social Work 481.

491. **Research Seminar.** Seminar for students preparing research projects, either in groups or individually. Experience in the application of research methods to current social work problems. 0 to 2 units. Prerequisite: Social Work 421 and 422, Section A2.

492. **Seminar on Models for Directed Change.** Same as Sociology and Urban Planning 492. Construction and analysis of models for planned intervention at the personal, small group, and community levels. Construction of models as interpretations of behavioral science theory; extrapolating of hypotheses and of guides to intervention from the models. Readings from several disciplines as relevant. ½ or 1 unit. Prerequisite: Consent of instructor.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. **Introduction to Social Casework.** Behavior and attitudes expressed by persons asking for assistance, the feelings thus engendered, and the effects of these upon the contacts of social caseworkers with individuals and families. Attention is given to case records selected from social casework practice in public assistance and other community agencies. ½ unit.

316. **Social Services for Children.** Unmet needs of children and the organization of social services to meet those needs. Responsibilities of voluntary as well as public agencies are considered. A survey is made of agencies providing leadership and standard-setting in social services for children. ½ or 1 unit. Prerequisite: A major in any of the social sciences, education, recreation, speech correction, or consent of instructor.

333. **Introduction to Social Group Work.** Background information regarding the place and development of social group work. Attention is given to the nature of groups in society, the development of group work services, concepts of group leadership, and the nature of group activities. Material is presented through lecture and discussion with illustrations from the field of practice in informal education, recreation, and social group work. ½ unit. Prerequisite: Introductory courses in sociology, psychology, and social sciences.

SOCIOLOGY

The Department of Sociology offers graduate work leading to the Master of Arts and Doctor of Philosophy.

In order to be considered for admission, students intending to major in sociology must offer:

(1) A grade-point average of at least 4.0 (applications of students with grade point averages below 4.0 but above 3.5 are considered on an individual basis);

(2) A minimum of nine semester hours of undergraduate work in sociology;

(3) One or more courses in quantitative research methods in sociology;

(4) Fifteen semester hours in one or more of the following subjects: anthropology, economics, history, mathematics, philosophy, political science, and psychology. Training in logic, philosophy of science, mathematics, and statistics is strongly recommended for students expecting to do graduate work in sociology.

The prerequisite for a graduate minor in sociology is six hours of undergraduate work in sociology.

Master of Arts. The requirements for the Master of Arts are: (1) eight units including Sociology 385, 386, and 400, and no more than one unit of thesis credit; (2) passing the departmental comprehensive examination on the master's level; (3) preparation of an acceptable thesis; (4) passing an oral examination on the thesis.

Doctor of Philosophy. Study for the doctorate must include Sociology 385, 386, 387, and 400, or equivalent. A manual for graduate students in sociology is available from the department.

GRADUATE FACULTY

Professors: D. Glaser (Head of Department), D. Bordua, B. Farber, C. L. Folse, J. R. Gusfield, J. E. Hulett, Jr., N. G. Jacobs, H. M. Johnson, B. Karsh, A. Vucinich.

Associate Professors: K. W. Dickman, Rita Simon, H. Y. Tien.

Associate Professors: N. K. Denzin, S. Kronus, M. Lewis, G. F. Summers.

COURSES FOR GRADUATES

400. **General Sociology.** Systematic sociology, with emphasis on the development and problems of modern structural-functional theory. Analysis of the works of major contributors to functionalism, e.g., Durkheim, Weber, Merton, and Parsons, and an examination of the ways in which their work converges to form a cumulative body of sociological theory. 1 unit.

407. **Population Studies and Demographic Analysis.** Same as Rural Sociology 407. Nature and development of population theories; population growth and measures of fertility, reproduction, mortality, morbidity, and internal migration; indices, rates, and standardizations used in analyzing compositional characteristics. Methods in population projections, relationship of economic, sociological, and psychological factors to population changes. 1 unit. Prerequisite: Twelve hours of social science and introductory statistics, or major in sociology, or consent of instructor. FOLSE.

408. **The Sociology of Human Fertility.** Comparative studies of levels of fertility in different societies and in the same societies at different times. Analysis of sociological, psychological, and demographic factors affecting human reproduction and family planning, and consequences of differentials in fertility. 1 unit. Prerequisite: Graduate standing or consent of instructor. TIEN.

409. **Psychological Scaling.** Same as Psychology 409. Scaling theory and methodology, with emphasis upon measurement in psychophysics, differential psychology, and social psychology. 1 unit. Offered in 1968-1969 and in alternate years. Prerequisite: Psychology 307. TUCKER.

411. **Sociology of Science.** Social factors in the origin of broad theoretical orientations in science, such as the mechanistic doctrine, vitalism, historicism, atomism, holism, relativism, and indeterminism; social effects of these orientations; the social origin of scientists; ethos of science; the relationship of science to culture change; the variety and nature of scientific institutions. 1 unit. Prerequisite: Sociology 311 or consent of instructor. VUCINICH.

412. **Seminar on Social and Cultural Relations of Personality.** Problems of theory, concepts, and methodology in the study of the relationship of individual personality and social behavior to culture and social organization. The course is based on a critical examination of the literature and touches on special aspects of the basic problem such as levels of culture, family and class structure, behavior disorders, and social change in relation to the individual. 1 unit. HULETT.

413. **Computer Applications in Social Statistical Research.** Same as Computer Science and Psychology 413. Computer procedures for the analysis of sociological and psychological data, including probability matrices, dominance matrices, clique analysis, regression analysis, analysis of variance and covariance, canonical correlations, discriminant analysis, and factor analysis. 1 unit. Prerequisite: Sociology 387 or equivalent in statistics; may be taken concurrently with Sociology 387. DICKMAN.

414. **Seminar on Social Interaction.** Same as Communications 414. An analysis of social interaction based on the social psychology of C. H. Cooley, G. H. Mead, and W. I. Thomas. Problems of theory, concepts, and method. 1 unit. Prerequisite: One unit of graduate credit in sociology. HULETT.

417. **Seminar in the Sociology of Law.** Review and analysis of selected areas of theory and research in the sociology of law. The focus varies from year to year. Topics covered in different years include such areas as civil litigation and the civil courts, police operations and the sociology of law and order, sociological theories of justice and the operations of legal agencies. Students should consult the instructor about the area to be covered in a particular semester. 1 unit. Prerequisite: Sociology 317. BORDUA.

418. Seminar in Industrial and Economic Sociology. Same as Labor and Industrial Relations 418. Discussion and individual research on such topics as industrialization, labor-management relations as group relations, the interrelations of industry and community, technology and the structure of controls in industry, and the problem of a social economics. 1 unit. Prerequisite: Sociology or Labor and Industrial Relations 318, or consent of instructor. KARSH.

421. Seminar on Research in Marriage and Family Life. Analysis of relationships between research methodology and conceptual schemes employed to study family life; critical examination of typical studies which illustrate alternatives in the conceptualization of family interaction and the nature of the family unit. 1 unit. Prerequisite: Consent of instructor. FARBER.

422. Theory of Social Groups. A comparative survey of selected conceptual systems currently used for the analysis of human groups. The systems are examined with a view to determining the origins and referents of the concepts, their interrelations, and their utility as sources of testable generalizations relevant to the solution of empirical problems in group analysis. 1 unit. DENZIN.

424. Sociological Analysis of Treatment Institutions. Analysis of research on the social structure of prisons, training schools, and mental hosptials; sociological approaches to measuring the effects of innovations in institution organization and program; measuring the influence of institutional experience on the post-release behavior of its inmates. Class makes one or more trips to institutions; total travel costs per student for the term not to exceed $10.00. 1 unit. Prerequisite: Sociology 324 and 333, or consent of instructor. DENZIN.

425. Racial and Cultural Minorities. A study of the factual and conceptual aspects of minority status as determined by racial and cultural criteria. 1 unit. Prerequisite: Undergraduate major or minor in sociology or anthropology.

426. Sociological Research on the Extramural Treatment of Deviant Behavior. Analysis of sociological research on community programs for the treatment and prevention of deviant behavior, including adjudication and disposition in delinquency and mental disorder, probation, parole, out-patient and day- or night-only care, work-release, community correctional treatment. Class makes one or more trips to observe field research; total travel cost for the term not to exceed $10.00. 1 unit. Prerequisite: Sociology 324 and 333, or consent of instructor. DENZIN.

429. Seminar in the Sociology of Religion. Detailed examination of research in the sociology of religion; the substantive character of religious groups and institutions as revealed by this research; significance of the research in the light of sociological theory and of other fields of sociological concern; the value of the current research methodology. 1 unit. Prerequisite: Sociology 400.

431. Seminar on Social Deviance. Systematic analysis of advanced theory and research on the social processes by which behavior becomes defined as deviant, the conditions promoting such behavior, and the career patterns of deviant persons, with particular attention to crime, delinquency, and mental disorder. 1 unit. Prerequisite: Sociology 331 and 333, or consent of instructor. BORDUA.

432. Special Problems in Theory and Research on Deviant Behavior. A seminar concerned with the critique of recent theory and research on selected problems in the study of delinquency, crime and mental disorder, and the collaborative development of new theory and research designs. 1 unit. Prerequisite: Sociology 331 and 333, or consent of instructor.

435. Field Instruction in Sociological Research on Treatment of Deviant Behavior. Problems of designing and conducting sociological research in agencies for the treatment of deviant behavior (prisons, training schools, police departments,

courts, mental clinics, mental hospitals); supervised training and practice in the functions of sociologists in these agencies. Application for admission to this course should be made early, perferably no later than the April prior to the summer session in which enrollment is desired, so that field placement arrangements can be made. S; 1 unit. Students may reregister in a subsequent summer for a second unit of credit, provided there is appreciable contrast in their two field locations. Prerequisite: Sociology 431, 333, and 424, or consent of instructor.

440. **Political Sociology.** An analysis of the impact of social cleavages and cohesion on the operation of political institutions and movements; the place of conflict and power in sociological theory; composition and behavior of power elites; participation in political associations; national and local power structure; social functions of electoral behavior; modern national and mass political movements. 1 unit. Prerequisite: A course in sociological theory or consent of instructor.

444. **Seminar in Public Opinion.** Same as Communications 444. Development and theory of public opinion process in society; censorship, interest groups, and propaganda; mass media and public opinion. 1 unit. SIMON.

450. **Problems of Soviet Society in Transition.** This seminar examines certain major problems inherent in directed social change from an agricultural to an industrial system under a totalitarian regime of the Soviet type. Attention is focused on such areas as the different phases of the revolutionary process, inconsistencies between ideological premises and the demands of industrialism, the unanticipated consequences of social change, the simultaneous impact upon the social system of industrialism and totalitarianism, and implications of the Soviet experience for other countries. 1 unit. Prerequisite: Consent of instructor. VUCINICH.

476. **Urban Communities and Urbanization.** Intensive study of special aspects of the urbanization process as it affects the life of communities in this and in other countries. 1 unit. KRONUS, LEWIS.

477. **Rural Community Organization and Development.** Same as Rural Sociology 477. Theories relating to the community concept as applied to rural life; the analysis of rural community organization; the process of community development as applied to rural cultures in various parts of the world. Field trip; estimated expense, $5.00. 1 unit. Prerequisite: Sociology 100 or Rural Sociology 117.

480. **Sociological Theory and Method.** This course is concerned with the strategy and tactics involved in the construction of specific substantive theories, considering such problems as concept formation, the use and development of models, criteria of good theory, and the role of theory in the development of sociological research. 1 unit.

482. **Recent Developments in Sociology.** Intensive study of selected topics based on contemporary works of major importance in the development of sociological theory. 1 unit. Students may reregister for a total of two units credit.

485. **The Sampling of Human Populations and Social Organizations.** Same as Psychology 485. This course covers procedures for selecting samples from and estimating population parameters for human populations and social organizations. The types of sample designs treated include simple random samples, stratified, and cluster samples together with random number and systematic selection techniques. Emphasis is given to the study of various kinds of advanced sample designs for both area and institutional settings together with the problems involved in the application of analytical statistics to complicated sampling procedures. Each student is required to participate in a field project which involves the actual selection of a cluster sample from the local area. 1 unit. Prerequisite: Sociology 387 or Economics 371, or consent of instructor.

486. **Seminar on Experimental Sociology.** The logic, design, and analysis of laboratory and field experiments, with special emphasis on the controlled investigation

of social processes. 1 unit. Prerequisite: Sociology 385 or equivalent, or consent of instructor. SUMMERS.

487. **Special Problems in Rural Sociology.** Same as Rural Sociology 487. ½ or 1 unit. Prerequisite: One unit of graduate credit in sociology; consent of instructor. STAFF.

490. **Individual Topics in Sociology.** Supervised individual investigation or study of a topic not covered by regular courses. The topic selected by the student and the proposed plan of study must be approved by the adviser and the staff member who supervises the work. ½ to 2 units. STAFF.

492. **Seminar on Models for Directed Change.** Same as Social Work and Urban Planning 492. Construction and analysis of models for planned intervention at the personal, small group, and community levels. Construction of models as interpretations of behavioral science theory; extrapolating of hypotheses and of guides to intervention from the models. Readings from several disciplines as relevant. ½ or 1 unit. Prerequisite: Consent of instructor.

493. **Multivariate Analysis in Psychology and Education.** Same as Educational Psychology and Psychology 494. The principal methods of descriptive statistics used in the analysis of multiple measurements, with emphasis on conventional procedures of factor analysis; profile similarity models; discriminatory analysis; multidimensional scaling. 1 unit. Prerequisite: Psychology 307 or Educational Psychology 496; consent of instructor. TUCKER.

499. **Thesis Research.** 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Social Systems and Institutions.** An advanced discussion of general principles and concepts in sociology; among the topics discussed are culture, social structure, socialization, primary groups, social stratification; their application to problems in political sociology, industrialization, race relations, religion, and delinquency; the bearing of these upon larger problems of social order and social change. Designed for advanced undergraduate majors in sociology and other social sciences and for graduate students in sociology without adequate preparation for graduate work. ½ or 1 unit. Prerequisite: Sociology 100 or eight hours of social science, or consent of instructor. JOHNSON.

311. **Sociology of Intellectual Life.** A comparative sociological analysis of the development of the intelligentsia in Europe and elsewhere. Central concerns include the institutional supports for intellectual work under various social and cultural conditions, the social origin and status of different types of intellectuals, the formation of distinct scientific traditions, and the relationships of these traditions to ideology, literature, and philosophy. This involves a critical scrutiny of the theoretical literature and methodology of the sociology of knowledge. ½ or 1 unit. Prerequisite: Sociology 100 or eight hours of social science, or consent of instructor. VUCINICH.

315. **Sociology of Education.** Same as History and Philosophy of Education 315. Objective comparative study of education as a social process in various cultures and historical periods, with main emphasis on present education in countries which share Western civilization. ½ or 1 unit. Prerequisite: Sociology 100, Division of General Studies or Sociology 151. SUMMERS.

316. **Sociology of Adolescence.** Adolescence in modern societies; social class, ethnic and minority group membership, and other variables as in social development, search for identity, inter-generational conflict, academic and social failure, and juvenile delinquency; the socializing institutions of family, education, peer culture, politics, religion, welfare and social control, the work world and recreation

and leisure. Emphasis on research. ½ or 1 unit. Prerequisite: Sociology 100, or Division of General Studies or Sociology 151.

317. **Sociology of Law.** A general treatment of the social origins and consequences of law and legal process. Special emphasis is placed on problems of legal change, on the structure and functioning of legal sanctions. Some attention is paid to law and law-like phenomena in other societies, including primitive societies, but the main focus is on American society. ½ or 1 unit. Prerequisite: Sociology 100. Bordua, Simon.

318. **Industry and Society.** Same as Labor and Industrial Relations 318. Introduction to the sociology of economic institutions; selected problems of technological change and industrialization; corporate organization and trade union structure; human relations in industry and the changing bases of managerial authority; changing consumption patterns and the redefinition of work and leisure. ½ or 1 unit. Prerequisite: Six hours of sociology including one of the following: Sociology 218, 223, 300, 322, 326, or consent of instructor. Karsh.

320. **Social Roles.** Contemporary role theory and related concepts such as social status and social interaction; age-sex, vocational, social class, and other role types; applications of this theory to the study of the socialization process and personal adjustment, and the analysis of critical group situations and social change. ½ or 1 unit. Prerequisite: Sociology 100, or Division of General Studies or Sociology 151. Hulett.

321. **Family, Kinship, and Crisis.** An analysis of family and kinship, with major concentration on the American family. Implications of the American kinship system for trends in courtship and mate selection, interaction among kin, and other areas of family life are investigated. Family crisis is used as a focus for analysis of family organization. ½ or 1 unit. Prerequisite: Sociology 185. Farber.

322. **Sociology of Bureaucracy and Administrative Organization.** An analysis of major types of formal organizations from the viewpoint of generalized theories of organization and of substantive theories of bureaucratization and rationalization. Among the formal organizations studied are business enterprises and unions, educational and medical institutions, and non-voluntary organizations. The interrelations between bureaucracy, ideology, and social structure are particularly emphasized. ½ or 1 unit. Prerequisite: Nine hours of sociology including Sociology 300, or consent of instructor.

323. **The Small Social Group.** Same as Psychology 323. Theory, observation, and analysis of face-to-face social groups, such as friendships, cliques, clubs, committees, and laboratory and experimental groups. Deals with the characteristics, functions, and forms of interaction of small groups and covers recent theoretical and empirical developments in this field of sociology. ½ or 1 unit. Prerequisite: Sociology 201 or Psychology 201. Denzin.

324. **Penology.** Probation; parole; methods of institutional treatment. ½ or 1 unit. Prerequisite: Sociology 331.

326. **Social Mobility and Class Structure.** An advanced course in social stratification, concerned with patterns, causes, and consequences of social mobility and immobility. Includes the analysis of rising and falling classes in industrial and developing countries and the circulation of political, social, and economic elites, as well as institutional sources of individual mobility. ½ or 1 unit. Prerequisite: Sociology 223 or consent of instructor. Tien.

328. **Sociology of Asian Religions.** A comparative study of the influences of religion on the societies of Asia, and vice versa, focused on the problems of social change and development. Concentration is upon the religions and social systems of Iran, India, Thailand, China, and Japan. ½ or 1 unit. Prerequisite: Sociology 229 or consent of instructor. Jacobs.

329. **Comparative Family Institutions.** Cross-cultural analysis of family institutions, with special reference to vital and demographic backgrounds and with stress on property, authority, and handling of deviance, and relationship to religion, economy, and polity. ½ or 1 unit. Prerequisite: Sociology 185. Farber, Lewis.

331. **Criminology.** Nature and extent of crime; past and present theories of crime causation; criminal behavior in American society and its relation to personal and cultural conditions. ½ or 1 unit. Prerequisite: Sociology 100, or Division of General Studies or Sociology 151.

332. **Research Methods in Social Psychology.** Same as Psychology 332. A lecture and laboratory course in the methods and techniques of social psychological research. Emphasis is given to methods for laboratory experiments on small groups. ½ or 1 unit. Prerequisite: Psychology 201 or Sociology 201; Psychology 235 or Sociology 184 and 185.

333. **Sociology of Mental Health.** Mental health issues from social organizational, demographic, and social psychological perspectives; definitions of mental illness and treatment practices relating to changing social psychological and political ideologies. The patient and the mental hospital, and the potential role of the behavioral scientist as an agent of research, treatment, and change, with special reference to current mental health action programs, are investigated. 1 unit. Prerequisite: Sociology 100, or Division of General Studies or Sociology 151, and one course in abnormal psychology and one in social psychology, or consent of instructor.

340. **Social Movements.** Analysis of the factors in the formation and dynamics of social movements as collective behavior; patterns of growth, types of leaders, control mechanisms. ½ or 1 unit. Prerequisite: Sociology 100, or Division of General Studies or Sociology 151. Gusfield.

343. **Social Change in Developing Areas.** Description and analysis of recent social and cultural changes occurring in new nations and developing economies. Special attention is given to problems of traditional social structure undergoing modernization. Social factors in economic growth, caste and class, nation-building, urbanization and population composition, education, family and religion. ½ or 1 unit. Prerequisite: Sociology 100, or Division of General Studies or Sociology 151 or equivalent. Jacobs, Karsh.

344. **Public Opinion.** Same as Communications 344. Opinion changes and control; propaganda; interest groups and opinion; critical review of methods of measurement. ½ unit. Prerequisite: Sociology 100, or Division of General Studies or Sociology 151. Simon.

350. **Soviet Social Institutions.** This course analyzes the major social institutions of Soviet society. Special attention is paid to the structural consequences of Communist ideology, totalitarianism and industrialism, and to comparison with and implications for American society. The major areas covered are: population data and their sociological implications; history, values, and ideology; political institutions; economic institutions; social stratification and mobility; the nationalities; the family and education; communications and public opinion; socialized medicine. ½ or 1 unit. Prerequisite: Sociology 100 or consent of instructor. The prerequisite does not apply to majors and minors in Russian language and area studies. Vucinich.

351. **Advanced Social Psychology.** Same as Communications and Psychology 351. An integrative treatment of individual behavior variables in relation to group variables. ½ or 1 unit. Prerequisite: Sociology 201 or Psychology 201; Psychology 235 or Sociology 385, or a comparable statistics course. McGrath, Steiner.

352. **Attitude Theory and Measurement.** Same as Communications and Psychology 352. A comprehensive survey of psychological theories of attitude organization

and change, and a theoretical and methodological analysis of the various techniques used to measure attitude. These theories and methods are evaluated with respect to empirical research in the area. ½ or 1 unit. Prerequisite: Sociology 201 or Psychology 201; a course in statistics. FISHBEIN.

355. **Chinese Society.** Systematic treatment of China's social, cultural, and demographic heritage and of the impact of the west on an ancient civilization; the processes of planned and unplanned change in Chinese society. Topics include: peasant-land economy; the family; patterns of social stratification and social mobility; the persistence of traditional forms and the adoption and adaptation of new patterns. ½ or 1 unit. Prerequisite: Sociology 100, Division of General Studies or Sociology 151 and 152, Rural Sociology 117, or consent of instructor. TIEN.

359. **The Social Psychology of Organization.** Same as Psychology 359. Analysis of the interrelationships between social and psychological factors, on the one hand, and organizational structure and process, on the other; emphasis on sources, consequences, and modes of resolution of intra-individual, intra-organizational, and inter-organizational conflict. 1 unit. Prerequisite: Psychology 355 or Sociology 322. DENZIN, MCGRATH.

360. **Sociology of the Professions.** This course examines the nature, position, functions, and growing importance of the major professions in the contemporary industrial (or industrializing) society. Particularly close attention is paid to the relationship between the social system and the various professional "communities," recruitment, professional socialization, and bureaucratic vs. independent practice. ½ or 1 unit. Prerequisite: Sociology 100 or consent of instructor. TIEN.

369. **Introduction to Human Ecology.** Same as Anthropology, Geography, Health Education, Physiology, Veterinary Medical Science, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations, and physiological, psychological, and sociological adjustments to environment, regulation of populations, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology; one year of anthropology, geography, geology, or sociology. TIEN, STAFF.

371. **Comparative Social Institutions.** This course examines, in a comparative perspective, some of the major institutional complexes of social systems, such as family and kinship structures, occupations, political institutions, and social stratification and mobility. Illustrative materials are drawn from a variety of societies, including primitive nonliterate societies and advanced industrial societies such as the United States, Germany, and the Soviet Union. ½ or 1 unit. Prerequisite: Sociology 100 or consent of instructor. JACOBS.

373. **Latin-American Social Organization and Institutions.** Analysis of contemporary institutional and social class structures in Latin-American communities and societies, and their relationship to certain religious and family patterns; the influence of past and present trends in urbanization, ecological organization, and population growth upon Latin-American social systems and institutional organization. ½ or 1 unit. Prerequisite: Sociology 100, or Division of General Studies or Sociology 151, or consent of instructor. SOLAUN.

374. **Problems in Human Ecology.** Same as Anthropology, Geography, Health Education, Physiology, Psychology, and Veterinary Medical Science 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multidisciplinary studies of selected current problems. 1 unit. Prerequisite: Sociology, Anthropology, Geography, Health Education, Physiology, or Zoology 369. TIEN, STAFF.

385. **Social Statistics, I.** Deals intensively with descriptive statistics, probability, statistical inference, and significance testing by means of both parametric and non-

parametric tests, and the various measures of association. 1 unit. Prerequisite: Sociology 185 or Mathematics 122 or 123, or consent of instructor.

386. Methods of Field Research. Same as Psychology 386. Instruction, training, and supervised practice in methods of field research as a basic tool of sociology. Major emphasis is placed on the role of the field researcher as participant, observer, and interviewer in various kinds of research settings, and on approaches to and applications of field data. Each student develops and executes a field research project dealing with some aspect of institutional, occupational, or general community activity and structure. ½ or 1 unit. Prerequisite: Sociology 184 and 185, or Psychology 235. DENZIN.

387. Social Statistics, II. Treats analysis of variance, analysis of covariance, multiple and partial correlations, and complicated sampling procedures. A semester problem is developed which emphasizes integration and application of various statistical techniques to sociological problems. ¾ or 1 unit. Prerequisite: Sociology 385.

SPANISH, ITALIAN, AND PORTUGUESE

The Department of Spanish, Italian, and Portuguese offers work leading to the Master of Arts and Doctor of Philosophy in Spanish, Italian, or Portuguese, and to a Master of Arts in the Teaching of Spanish. Fields of concentration are Spanish linguistics, Spanish literature, Latin-American literature, Italian literature, and Portuguese literature.

The departmental admission requirement is a grade-point average of at least 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis. Prerequisite for a graduate major is an undergraduate major in one Romance language or Latin, or consent of the department. Prerequisite for a minor is consent of the department.

Students doing graduate work for any advanced degree in Spanish must possess or acquire a practical command of the language. For the Doctor of Philosophy, some knowledge of Latin and Italian or Portuguese is required. The Latin requirement may be met by taking a minimum of one semester of Latin (two semesters in the specialization in Spanish linguistics) while in residence for the degree. Parallel training in one or more other languages or literatures, such as English, French, German, Greek, Italian, Latin, and Portuguese, is desirable.

Master of Arts.

(1) *Spanish or Spanish-American Literature.* Minimum requirements are: (a) any of the following not previously included in an undergraduate program: Spanish 305, 306, 307, 308, 309, 311, 314, 331 or 332, 351, 352; (b) Spanish 405; one of Spanish 415, 417, 419, 425; two of Spanish 421, 422, 423, 424, 426; one of Spanish 431, 432, 433, 434, 437, 438. The course program may be supplemented by courses from the doctoral list or by courses totaling one or two units in a minor or one unit in each of two minors.

(2) *Spanish Linguistics.* Minimum requirements are: (a) any of the following not previously included in an undergraduate program: Spanish 305, 306, 307, 308, 309, 311, 314, 331 or 332, 351, 352, 382; general linguistics: Linguistics 300, 302; and (b) Spanish linguistics: Spanish 451 or 453; general linguistics: Linguistics 462; Spanish and Spanish-American literature: one each from two of the following groups: (i) Spanish 415, 417, 419, 425; (ii) Spanish 421, 422, 423, 424, 426; (iii) Spanish 431, 432, 433, 434, 437, 438, 439. The course program may be supplemented by courses from the doctoral list.

(3) *The Teaching of Spanish.* Minimum requirements are: (a) up to three units of any of the following not previously included in an undergraduate program: Spanish 305 or 306, 307 or 308, 311 or 314, and 331, 332, 351, 352, Linguistics 300; (b) one of Spanish 415, 417, 419, 425; one of Spanish 421, 422, 423, 424, 426; one of Spanish

431, 432, 433, 434, 437, 438; (c) Educational Psychology 311, 312; (d) two of History and Philosophy of Education 301, 302, 303, 304. The course program may be supplemented by courses from the doctoral list. See pages 45 and 46.

Doctor of Philosophy.

(1) *With Specialization in the Renaissance and Golden Age.* The minimum requirements, in addition to those for the master's degree, are: Spanish 411; three of Spanish 415, 417, 419, 425; one of Spanish 421, 422, 423, 424, 426; Spanish 453; two seminars.

(2) *With Specialization in the Nineteenth and Twentieth Centuries.* The minimum requirements, in addition to those for the master's degree, are: Spanish 411, one of Spanish 415, 417, 419, 425; three of Spanish 421, 422, 423, 424, 426; Spanish 453; two seminars.

(3) *With Specialization in Latin-American Literature.* The minimum requirements, in addition to those for the master's degree, are: Spanish 411; one of Spanish 415, 417, 419, 425; one of Spanish 421, 422, 423, 424, 426; Spanish 453; three of Spanish 431, 432, 433, 434, 437, 438, 439; two seminars; one of Portuguese 301, 303, 304, 407.

(4) *With Specialization in Spanish Linguistics.* The minimum requirements, in addition to those for the master's degree, are: (a) Spanish linguistics: Spanish 454 and 451 or 435; (b) Spanish and Spanish-American literature: Spanish 411, and one each from two of the following groups: (i) Spanish 425 or other (415, 417, 419); (ii) Spanish 426 or other (421, 422, 423, 424); (iii) Spanish 431 or 432 or other (433, 434, 437, 438); (c) two seminars: Spanish 452 and one in literature or language or general linguistics; (d) minor: general linguistics.

Students working toward the Doctor of Philosophy are admitted with provisional departmental status until their performance in graduate work is judged acceptable for full departmental status by the department's graduate committee.

The department should be consulted on the selection of minors. Minors available within the department are Spanish philology and linguistics; Italian; Portuguese; Spanish and Latin-American literature. Other minors are other languages and literatures, history, philosophy, anthropology, linguistics, Latin-American studies, and other closely allied subjects.

Candidates for an advanced degree in Italian or Portuguese should consult the department. Provisions are made to fit individual cases.

GRADUATE FACULTY

Professors: W. H. Shoemaker (Head of Department), J. H. D. Allen, J. S. Flores, H. R. Kahane, L. Leal, M. A. Morinigo, Angelina R. Pietrangeli.

Associate Professors: S. W. Baldwin, Jr., W. C. Blaylock, M. H. Forster, R. E. Lott.

Assistant Professors: I. R. Hershberg, T. C. Meehan, W. L. Meinhardt.

Spanish

COURSES FOR GRADUATES

400. Beginning Spanish for Graduate Students. Basic grammar and vocabulary; reading practice. No graduate credit.

405. Spanish Bibliography. An introduction to bibliographical method and to the principal bibliographical resources for the study of Spanish and Latin-American literature. ½ unit. Blaylock.

411. Spanish Literature in the Middle Ages. 1 unit. Prerequisite: Spanish 309. Allen.

415. Renaissance and Baroque Prose in Spain. 1 unit. Prerequisite: Spanish 311 and 314, or equivalent. Allen.

417. Renaissance and Baroque Drama in Spain. 1 unit. Prerequisite: Spanish 311 and 314, or equivalent. FLORES, MORÍNIGO.

418. Seminar in Renaissance and Baroque Literature. 1 unit. Prerequisite: Spanish 415 or 417. MORÍNIGO.

419. Cervantes. *Don Quixote* and representative minor works. 1 unit. Prerequisite: Spanish 311 and 314, or equivalent. MORÍNIGO.

421. Modern Spanish Novel and Essay. 1 unit. SHOEMAKER.

422. Contemporary Spanish Novel and Essay. 1 unit. SHOEMAKER.

423. Modern Spanish Drama. 1 unit. LOTT, PIETRANGELI, SHOEMAKER.

424. Contemporary Spanish Drama. 1 unit. LOTT, SHOEMAKER.

425. Renaissance and Baroque Poetry in Spain. 1 unit.

426. Spanish Poetry of the Nineteenth and Twentieth Centuries. 1 unit. PIETRANGELI.

431. Spanish-American Poetry: Middle America. 1 unit. Prerequisite: Spanish 307 and 308, or equivalent. FORSTER.

432. Spanish-American Poetry: South America. 1 unit. Prerequisite: Spanish 307 and 308, or equivalent. FORSTER.

433. Spanish-American Novel: Middle America. 1 unit. Prerequisite: Spanish 307 and 308, or equivalent. LEAL.

434. Spanish-American Novel: South America. 1 unit. Prerequisite: Spanish 307 and 308, or equivalent. LEAL.

435. Seminar in Spanish-American Poetry. 1 unit. Prerequisite: Spanish 431 or 432. FORSTER.

436. Seminar in Spanish-American Novel. 1 unit. Prerequisite: Spanish 433 or 434. LEAL.

437. Spanish-American Drama. 1 unit. Prerequisite: Spanish 307 or 308. FORSTER.

438. Spanish-American Essay. 1 unit. Prerequisite: Spanish 307 or 308. LEAL.

439. The Spanish-American Short Story. Intensive and analytical study of the principal *cuentistas* of Spanish America. 1 unit. Prerequisite: Spanish 307 or 308, or equivalent.

442. Seminar in Modern Spanish Literature. Study of problems in the works of a major writer or group of writers of the eighteenth or nineteenth centuries. 1 unit. Prerequisite: Spanish 305; Spanish 421 or 423, or equivalent.

443. Seminar in Galdós. Research work in novelistic criticism. Prerequisite: Spanish 305 or 306 and 311 or 314; Spanish 421 or 422. 1 unit. SHOEMAKER.

444. Seminary in Spanish Realism and Naturalism. Research work in nineteenth-century literary theory and practice in novel and drama. 1 unit. Prerequisite: Spanish 421 and 422. SHOEMAKER.

445. Seminar in Twentieth-Century Spanish Literature. 1 unit. Prerequisite: Spanish 421 or 422 or 423 or 424, or equivalent. LOTT, SHOEMAKER.

451. Survey of Current Research in Spanish Linguistics. Present-day methods of comparative, historical, and structural linguistics as applied to Spanish. 1 unit. KAHANE.

452. Seminar in Spanish Linguistics. Research work in Castilian and Latin-American linguistics. 1 unit. KAHANE, MORÍNIGO.

453. History of the Spanish Language. 1 unit. KAHANE, MORÍNIGO.

454. **Old Spanish.** 1 unit. Blaylock, Kahane, Morínigo.

462. **Introduction to Romance Linguistics.** See Linguistics 462. ½ unit. Prerequisite: Four semesters of a Romance language or Latin, or equivalent.

471. **Teaching College Spanish.** A presentation of the problems of the teaching of Spanish and training in their solution, together with a study of procedures, methods, and laboratory techniques. No credit. Flores.

491. **Special Topics in Spanish.** ½ or 1 unit. Staff.

499. **Thesis Research.** 0 to 4 units. Allen, Forster, Kahane, Leal, Lott, Morínigo, Pietrangeli, Shoemaker.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

305. **Romanticism and Realism in Nineteenth-Century Spanish Literature.** A study of representative authors and genres of the nineteenth century, with particular emphasis on the romantic drama and the realistic novel. ½ unit. Prerequisite: Spanish 222 or equivalent. Lott.

306. **The Generation of 1898.** A study of representative works of Baroja, Azorín, Unamuno, Maeztu, Valle Inclán, Benavente, A. Machado, and others. ½ unit. Prerequisite: Spanish 222 or equivalent. Lott.

307. **Spanish-American Literature to 1888.** A study of the development of Spanish-American literature from the sixteenth century through the end of the Romantic period. ½ unit. Prerequisite: Spanish 222 or equivalent. Forster, Leal, Meinhardt.

308. ***Modernismo* and Contemporary Spanish-American Poetry.** A study of Spanish-American poetry from 1888 to the present; some attention is given to *modernista* prose. ½ unit. Prerequisite: Spanish 222 or equivalent. Forster, Leal, Meinhardt.

309. **Introduction to Medieval Spanish Literature.** Historical and cultural background for the Middle Ages; selected readings in medieval literature from the *Farchas* to the *Corbacho*. ½ unit. Prerequisite: Spanish 305, 306, 307, or 308, or equivalent.

311. ***Don Quixote* and the Prose of the Golden Age.** Introduction to *Don Quixote*, to its relationship to other selected masterpieces of the Golden Age, and to the main currents and forms of Golden Age prose. ½ unit. Prerequisite: Spanish 305, 306, 307, or 308, or equivalent. Leal.

314. **Spanish Drama and Poetry of the Golden Age.** ½ unit. Prerequisite: Spanish 305, 306, 307, or 308, or equivalent. Flores, Hershberg, Morínigo.

331. **La Cultura Hispánica: España.** ½ unit. Prerequisite: Spanish 222 or equivalent. Morínigo.

332. **La Cultura Hispánica: Hispanoamérica.** Required for teacher-training majors in Spanish. ½ unit. Prerequisite: Spanish 222 or equivalent. Leal, Meinhardt, Morínigo.

351. **Phonetics.** ½ unit. Prerequisite: Spanish 222 or equivalent. Allen, Baldwin, Flores, Kahane.

352. **Syntax.** ½ unit. Prerequisite: Spanish 222 or equivalent. Baldwin, Blaylock, Kahane, Shoemaker.

371. **Spanish for Teachers.** A consideration of language problems suggested by teaching experience. S; ½ unit. Prerequisite: Spanish 222 or equivalent. Flores.

382. **Language Laboratory Techniques.** Same as French, German, and Russian 382. Instruction and practice in the techniques of making foreign-language tapes and

integrating them with classroom activity; instruction in the problems of planning and operating a language laboratory. ½ unit. Prerequisite: Three years of a modern foreign language at the college level, or equivalent. MYERS.

Italian

COURSES FOR GRADUATES

400. Beginning Course for Graduate Students. Basic grammar and vocabulary; reading practice. No graduate credit.

411. Italian Literature in the Middle Ages: Petrarch and Boccaccio. 1 unit. PIETRANGELI.

412. Italian Literature in the Middle Ages: Petrarch and Boccaccio. 1 unit. PIETRANGELI.

415. Italian Literature of the Renaissance. 1 unit. PIETRANGELI.

416. Italian Literature of the Renaissance. 1 unit. PIETRANGELI.

451. History of the Italian Language. 1 unit. KAHANE.

452. Seminar in Italian Linguistics. 1 unit. KAHANE.

462. Introduction to Romance Linguistics. See Linguistics 462. ½ unit. Prerequisite: Four semesters of a Romance language or Latin, or equivalent.

491. Special Topics in Italian. ½ or 1 unit.

499. Thesis Research. 0 to 4 units. KAHANE.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

Note: The prerequisite for 300-level courses is Italian 101 and 102. Italian 103 and 104 are desirable.

311. Dante: *La Divina Commedia*. ½ unit. PIETRANGELI.

312. Dante: *La Divina Commedia*. Continuation of Italian 311. ½ unit. PIETRANGELI.

313. The *Divine Comedy*. Same as Comparative Literature 313. An interpretation of Dante's *Divine Comedy* with special attention to its position in the medieval world. A knowledge of Italian is not required. ½ unit.

321. Modern Italian Literature. ½ unit. HERSHBERG, PIETRANGELI.

322. Modern Italian Literature. ½ unit. HERSHBERG, PIETRANGELI.

Portuguese

COURSES FOR GRADUATES

405. Structure of Brazilian Portuguese: Phonology. Phonetics and phonemics of modern Brazilian Portuguese. 1 unit. Prerequisite: Portuguese 104 or consent of instructor. ALLEN.

406. Structure of Brazilian Portuguese: Morphology and Syntax. Morphemics and syntax of modern Brazilian Portuguese. 1 unit. Prerequisite: Portuguese 405 or consent of instructor. ALLEN.

407. Studies in Brazilian Literature. Advanced study of literary movements, major writers, and intellectual and cultural ideas in Brazilian literature. The subject

matter of the course varies each time the course is offered. 1 unit. Prerequisite: Portuguese 301 or consent of instructor. ALLEN.

408. Studies in Portuguese Literature. Advanced study of literary movements, major writers, and intellectual and cultural ideas in Portuguese literature. The subject matter of the course varies each time the course is offered. 1 unit. Prerequisite: Portuguese 302 or consent of instructor. FORSTER.

462. Introduction to Romance Linguistics. See Linguistics 462. ½ unit. Prerequisite: Four semesters of a Romance language or Latin, or equivalent. KAHANE.

491. Special Topics in Portuguese. ½ or 1 unit. STAFF.

499. Thesis Research. 0 to 4 units. ALLEN, FORSTER, KAHANE.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Introduction to Brazilian Literature. ½ unit. Prerequisite: Portuguese 201 or consent of instructor.

302. Introduction to Portuguese Literature. ½ unit. Prerequisite: Portuguese 201 or consent of instructor.

303. A Cultura Luso-Brasileira até 1822. Designed to afford a broad understanding of the origins of Luso-Brazilian civilization and culture. ½ or 1 unit. Prerequisite: Portuguese 201 or 211 or consent of instructor.

304. A Cultura Brasileira desde 1822. Designed to afford a broad understanding of contemporary Brazilian civilization and culture. ½ or 1 unit. Prerequisite: Portuguese 201 or 211 or consent of instructor.

SPEECH

The Department of Speech offers courses leading to the Master of Arts, Master of Science, and Doctor of Philosophy.

Graduate students interested in the theatre option for the Master of Arts and the Doctor of Philosophy are referred to course listings in the Department of Theatre, page 375, as well as applicable courses listed below.

The admission requirement, in terms of grade-point average, is at least 3.5.

For the degree of Master of Arts, students may concentrate in one of these areas: general speech, public address, theatre, oral interpretation, speech and hearing science. They may also select a special curriculum in the teaching of speech.

For the Master of Science, students may take a special curriculum in speech correction.

For the Doctor of Philosophy, students may exercise one of five options: rhetoric and public address; the theatre; speech and hearing science; experimental phonetics; oral interpretation.

In addition to meeting general regulations of the Graduate College, the Department of Speech specifies the requirements listed below.

Master of Arts. The entering student should present the equivalent of sixteen hours of undergraduate work in speech, including these courses or equivalents: voice and diction or fundamentals of speech, oral interpretation, an elementary course in phonetics, an elementary course in the theatre, and an advanced course in public speaking or discussion. A thesis may be required.

A final written examination is required of all candidates. In some cases an oral examination is also stipulated.

Master of Arts in the Teaching of Speech. Candidates for the Master of Arts who are interested in public school teaching should see pages 45 and 46 and also meet the following requirements:

(1) In the area of rhetoric and public address: Speech 311 and 312, one-half unit each; Speech 322 and 423, one unit each; and education, two units, including the following: History and Philosophy of Education 304 and 305, one unit, and Educational Psychology 311 and 312, one unit; electives, three units, one of which must be in speech.

(2) In the area of theatre: speech, four units, including Speech 352, 451, 452, or equivalent, and one of the following: Speech 361, 362, or 366; education, two units, including the following: History and Philosophy of Education 304 and 305, and Educational Psychology 311 and 312; electives, two units.

Master of Science in Speech Correction. The four-year curriculum preparatory to speech correction or its equivalent is a prerequisite for admission. Students who have not met all the requirements may register on approval of the adviser, the Coordinator of Teacher Education, and the Dean of the Graduate College.

Requirements include four units of speech selected from the following: Speech 475, 476, 481, 483, 484, 486, 488, 489, 491, 495; one unit from History and Philosophy of Education 304 and 305, and one unit from Educational Psychology 311 and 312; two units of electives. The electives may be in speech, in psychology, or, in exceptional cases, in other fields.

Doctor of Philosophy. Students are accepted as candidates for the doctor's degree who present either a well-rounded undergraduate education with at least sixteen hours of credit in speech or who hold a master's degree in speech or theatre from an accredited institution.

GRADUATE FACULTY

Professors: Clara M. Behringer, B. W. Hewitt, H. L. Mueller, R. Murphy, Marie H. Nichols, J. J. O'Neill, J. W. Scott, C. H. Shattuck.

Associate Professors: Mary H. Arbenz, J. J. Bateman, K. W. Broadrick, K. Burns, A. J. Derbyshire, Genevieve Richardson, T. M. Scheidel, T. O. Sloan, W. L. Smalley, B. R. Works, W. R. Zemlin.

Assistant Professors: R. D. Brooks, Ruth Ann Clark, Joanna L. Hawkins, R. L. Ince, F. L. Nasca, Elaine P. Paden, T. H. Shriner, R. K. Simpson, E. W. Stark, J. W. Wenzel.

COURSES FOR GRADUATES

403. Seminar for Teachers of Speech. Investigation of current principles, materials, and developments in the field of speech and of their relationship to the teacher. 1 unit. Burns.

411. The Greek Tradition in Rheotric and Oratory. The development of the Greek tradition in rhetorical theory, practice, criticism, and pedagogy from Homer to the Renaissance; analysis of the contributions of major figures and works to that tradition. 1 unit. Bateman.

412. The Roman Tradition in Rhetoric and Oratory. Development of the Roman tradition in rhetorical thought and practice from Cicero through the English Renaissance. 1 unit.

420. Quantitative Methods in Rhetorical Analysis. An introduction to the principles, procedures, and tools of research used in the quantitative analysis of the oral communication situation, including the experimental designs and statistical methods applicable to rhetorical analysis, and the identification, control, and measurement of rhetorical variables. Students participate in planning, executing, and reporting a limited experimental project investigating some oral communication variable. 1 unit. Offered in 1968-1969 and in alternate years. Prerequisite: Introductory course in statistics; consent of instructor. Scheidel.

423. **The *Rhetoric* of Aristotle.** Study of the *Rhetoric* in relation to other works of Aristotle. 1 unit.

430. **Contemporary Theories of Oral Communication.** Systematic study of speech-making and discussion as related to contemporary views of communication; examination of the theoretical literature and experimental evidence. 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Consent of instructor. SCHEIDEL.

436. **Seminar in Public Discussion.** Investigation of special problems in public discussion. 1 unit. Offered in 1969-1970 and in alternate years. MURPHY.

438. **Seminar in Rhetorical Theory.** Study of special topics in the history of rhetorical theory. 1 unit.

441. **Historical Background of Oral Interpretation.** Historical survey of British and American theories of interpretation. 1 unit. SLOAN.

442. **Seminar in Oral Interpretation.** Investigation of basic problems in the history, nature, and function of oral interpretation. 1 unit. Prerequisite: Speech 441; consent of instructor. SLOAN.

443. **Seminar in the Oral Interpretation of Individual Literary Style.** Examination of the literary style of an individual writer or selected writers through research, discussion, and oral readings; subject announced each semester. 1 unit; may be repeated for a maximum of 2 units. Prerequisite: Speech 344.

451. **Problems in Play Directing in the Educational Theatre.** Same as Theatre 451. Study of the audience, play selection, the actor's abilities and needs, tryouts and casting, conduct of rehearsals and methods of directing, the dramatic club, contests and festivals. 1 unit. BEHRINGER.

452. **Problems in Play Production in the Educational Theatre.** Same as Theatre 452. Study of the school auditoria and stages, stage machinery and equipment and their use, lighting facilities and their use, organization of backstage crews, scene shifting and stage management, production problems of special types of plays. 1 unit. BEHRINGER.

469. **The Stage History of Classic English Plays.** Same as Theatre and English 469. Analysis and reconstruction of past productions of classic plays, with special reference to Shakespeare. 1 unit. Prerequisite: One year of work in dramatic literature or theatre history; consent of instructor. SHATTUCK.

472. **Psychoacoustics of Speech.** Theory and principles of auditory perception of speech; survey of experimental and theoretical literature; laboratory demonstration and experimentation. 1 unit. Prerequisite: Speech 375, 376, 391, or consent of instructor. O'NEILL.

473. **Seminar in Phonetics.** Same as Linguistics 473. Advanced study in phonetic theory and nonistrumental phonetic investigation. 1 unit. Prerequisite: Consent of instructor.

475. **Experimental Phonetics, I.** Same as Linguistics 475. Theoretical consideration of speech as motor behavior, with special reference to physiological investigations of normal respiration, phonation, and articulation. Survey of the experimental literature. 1 unit. Prerequisite: Consent of instructor. ZEMLIN.

476. **Experimental Phonetics, II.** Same as Linguistics 476. Theoretical consideration of speech as an acoustical phenomenon, with special reference to acoustical investigations of voice and speech sounds. Survey of the experimental literature. 1 unit. Prerequisite: Consent of instructor. ZEMLIN.

477. **Measurement of Speech, I.** Same as Linguistics 477. Principles and methods of measuring speech action. Special action recorders and transducers; techniques of

analysis; problems of experimental design. Laboratory experimentation. 1 unit. Prerequisite: Consent of instructor; credit or registration in Speech 475. ZEMLIN.

478. Measurement of Speech, II. Same as Linguistics 478. Principles and methods of measuring the acoustical phenomena of speech. Oscillographic measurement of vocal variables; special instruments and media for automatic graphic recording; analysis of data; problems of experimental design. Laboratory experimentation. 1 unit. Prerequisite: Consent of instructor; credit or registration in Speech 476. ZEMLIN.

481. Seminar in Neuropathologies of Speech and Language. Advanced study of speech, vocal, and linguistic problems associated with cerebral palsy, aphasia, and mental retardation. 1 unit. Prerequisite: Consent of instructor.

482. Seminar in Stuttering. Principles, theories, and methods of clinical management of stuttering behavior in children and adults. 1 unit. Prerequisite: Speech 388.

483. Psychology of Speech and Hearing Disorders, I. Same as Psychology 483. A survey of psychological techniques utilized in the clinical and experimental study of speech and hearing disorders, with special reference to speech disorders. Review of research findings and development of experimental designs. 1 unit. Prerequisite: Consent of instructor. O'NEILL.

484. Psychology of Speech and Hearing Disorders, II. Same as Psychology 484. A survey of psychological techniques utilized in the clinical and experimental study of speech and hearing disorders, with special reference to hearing disorders. Review of research findings and development of experimental designs. 1 unit. Prerequisite: Consent of instructor. O'NEILL.

486. Advanced Clinical Techniques in Speech and Hearing. Advanced clinical techniques to be used in the management of speech and hearing disorders; semi-independent management of complex cases; particpation in examination and analysis. ½ to 4 units. Prerequisite: Consent of instructor.

488. Diagnostic Procedures in Pathologies of Speech and Language. Study of diagnostic procedures used in the analysis of neuropathologies of speech and language and orofacial and laryngeal pathologies of speech. 1 unit. Prerequisite: Consent of instructor.

489. Seminar in Orofacial and Laryngeal Pathologies of Speech. Advanced study of speech and vocal problems associated with cleft palate, laryngeal dysfunctions and facial-maxillary disturbances. 1 unit. Prerequisite: Consent of instructor.

490. Medical Aspects of Speech Disorders and Audiology. Study of acute and chronic hearing and speech disorders traceable to disease of the ear and vocal mechanisms in relation to the techniques and philosophies utilized in a medically oriented environment. 1 unit. Prerequisite: Speech 385, 388, and 486. O'NEILL.

491. Seminar in Hearing Disorders. Principles and methods of clinical and classroom management of all types of hearing disorders. Survey of current literature and research. 1 unit. Offered in 1968-1969 and in alternate years. Prerequisite: Speech 391.

492. Advanced Audiology. Advanced study of rationale and development of principles associated with special techniques, procedures, and methods used in audiology. 1 unit. Prerequisite: Speech 395 and 397. STARK.

495. Special Problems. Individual investigation of special projects not included in theses. Open to master's candidates for one unit, to doctor's candidates for one or two units. 1 to 2 units. Prerequisite: Consent of head of department. STAFF.

499. Thesis Research. 0 to 4 units. BATEMAN, BEHRINGER, BROADRICK, BROOKS, BURNS, CLARK, HAWKINS, HEWITT, INCE, MURPHY, NICHOLS, O'NEILL, SCHEIDEL, SCOTT, SHATTUCK, SHRINER, SLOAN, STARK, WENZEL, ZEMLIN.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **General Phonetics.** Basic principles of phonetic study, including observation and representation of pronunciation; ear training; practice in transcription. ½ or 1 unit. PADEN.

307. **The Art of the Screen: Narration.** Same as Communications 307. Critical study of the adaptation and synthesis of principles of drama, literature, the graphic arts, and music in the evolution of the screen narrative. Lectures, discussions, and reports; viewing of selected films and television programs. ½ unit. Prerequisite: Training in critical approaches to literature, drama, art, or music; consent of instructor. MUELLER.

308. **The Art of the Screen: Exposition and Persuasion.** Same as Communications 308. Critical study of the application of the eclectic principles of the screen narrative to the transmission of information and the influencing of attitude, opinion, and action. Lectures, discussions, and reports; viewing of selected films and television programs. ½ unit. Prerequisite: Speech 307 or consent of instructor. The prerequisite does not apply to students of library science who have obtained the necessary background through independent reading. MUELLER.

311. **British Public Address.** Study of representative British speakers from the sixteenth century to the present. Lectures, reports and papers. ½ or 1 unit. MURPHY.

312. **American Public Address.** Study of representative American speeches from the sixteenth century to the present. ½ or 1 unit. BROADRICK.

313. **Interpersonal Communication: Discussion and Interview.** Advanced study of theory, research, techniques, and training methods in interviewing and group discussion; emphasis on empirical research findings concerning communication processes in face-to-face groups. ½ or 1 unit. Prerequisite: Consent of instructor.

321. **Theories of Persuasion and Rhetorical Practice.** A survey of theories of persuasion derived from rhetorical, philosophical, and psychological sources and their application to persuasive discourse. ½ or 1 unit. Prerequisite: Consent of instructor.

322. **Modern Rhetorical Theory.** Significant movements in the development of rhetorical theory in England, France, and America from 1700 to the present. ½ or 1 unit. NICHOLS.

323. **Rhetorical Criticism.** Methods of interpreting and judging persuasive discourse with emphasis on political speaking and writing. Lectures and practice in criticism. ½ or 1 unit. Prerequisite: Credit or registration in Speech 311, 312, or 322. NICHOLS.

342. **Oral Interpretation of Poetry.** Analysis and oral presentation of literature representative of various poetic forms. ½ or 1 unit. Prerequisite: Speech 141. BURNS, HAWKINS, SLOAN.

345. **Contemporary Approaches to Oral Interpretation.** Modern concepts underlying the relationship of interpretation to the reader's experience of literature; discussions, reports, oral interpretations of prose forms (including Chamber Theatre and Readers Theatre). ½ or 1 unit. Prerequisite: Speech 141 or consent of instructor. HAWKINS, SLOAN.

352. **Introduction to Modern Theatre Art.** Same as Theatre 352. Origins and development of modern theatrical production; a critical examination of contemporary ideas and practices in theatre architecture, acting, directing, and staging. ½ or 1 unit. HEWITT.

361. **History of the European Theatre to the Renaissance.** Same as Theatre 361. The theatre and the theatre arts of ancient and of medieval Europe. ½ or 1 unit. SCOTT.

362. History of the European Theatre from the Renaissance to 1900. Same as Theatre 362. The European theatre and the theatre arts from 1576 to 1900, with special reference to the English theatre. ½ or 1 unit. SCOTT.

363. Advanced Dramatic Writing. Same as English 363, Radio and Television 363, and Theatre 380. Application of principles of dramatic form and structure to the more complex problems of playwriting. Practice in writing sustained dramatic forms. ½ or 1 unit; students may accumulate 2 units of credit. Prerequisite: Speech 263 or equivalent; consent of instructor. SMALLEY.

366. Development of the American Theatre. Same as Theatre 366. The development of the theatre and of theatre arts in America from colonial times to the beginning of the twentieth century. ½ or 1 unit. HEWITT.

371. History and Principles of Literary and Rhetorical Criticism: Aristotle to Sidney. Same as English 371. ½ or 1 unit.

372. History and Principles of Literary and Rhetorical Criticism: Sidney to the Present. Same as English 372. ½ or 1 unit.

375. Speech Science, I. Same as Linguistics 375. Introduction to the anatomical and physiological characteristics of the normal speech and hearing mechanisms. ½ unit. Prerequisite: Speech 109 or 301, or consent of instructor. ZEMLIN.

376. Speech Science, II. Same as Linguistics 376. Consideration of the physiology of the speaking act, the acoustical characteristics of voice and speech sounds, and the hearing of speech. ½ unit. Prerequisite: Speech 375 or consent of instructor. ZEMLIN.

377. The Bases of Speech and Hearing Science. An introduction to the anatomical and physiological characteristics of the normal speech and hearing mechanisms, the acoustical characteristics of speech, and the hearing of speech. Not open to students with credit in Speech 375 or 376. ½ unit. Prerequisite: Speech 109 or equivalent; consent of instructor.

383. Development of Spoken Language. A study of the correlates of language development from the prelinguistic period to adulthood. ½ or 1 unit. Prerequisite: Consent of instructor.

385. Speech Pathology, I. Study of the causes, symptoms, and treatment of speech disorders, including articulatory, vocal, and rhythmical disorders; observation of clinical techniques is required. ½ unit. Prerequisite: Ten hours of speech including Speech 109 and credit or registration in Speech 375, or consent of instructor. SIMPSON.

386. Basic Diagnostic and Therapeutic Principles of Speech Correction. Instruction and practice in the administration and interpretation of diagnostic tests; discussion and demonstration of clinical approaches used with speech disorders. ½ unit. Prerequisite: Speech 385; credit or registration in Speech 388.

387. Practicum in Speech Diagnosis and Therapy. Observation, practice, and research in diagnosis and therapy of speech disorder. ½ unit. Prerequisite: Speech 386; a grade-point average of at least 3.5; consent of instructor.

388. Speech Pathology, II. Study of causes, symptoms, and treatment of speech disorders, including stuttering, cerebral palsy, aphasia, and cleft palate. ½ or 1 unit. Prerequisite: Speech 385. SIMPSON.

390. Communication Disorders in Children: Habilitation and Rehabilitation. Principles of differential diagnosis, therapeutic diagnosis, clinical and classroom habilitation and rehabilitation of children with communicative disorders etiologically associated with neurological impairment, emotional disturbance, environmental deprivation, bilingualism, and mental retardation. ½ or 1 unit. Prerequisite: Speech 383; consent of instructor.

391. **Introduction to Hearing Disorders.** Analysis of symptoms and causes of hearing losses; effects of hearing loss upon oral communication, education, and psychological adjustment; principles of retraining the hard-of-hearing. ½ unit. Prerequisite: Speech 375 or consent of instructor. STARK.

393. **Aural Rehabilitation.** Principles and methods of clinical and classroom retraining of the hard-of-hearing, including lip reading, auditory training, speech correction and conservation, counseling. Required in curriculum of teacher training in speech correction. ½ or 1 unit. Prerequisite: Speech 391; a grade-point average of at least 3.5; consent of instructor. NASCA.

394. **Hearing Conservation.** A survey of auditory screening methods, educational and protective measures, and follow-up procedures utilized in public health, public school, and college, military, and industrial settings. ½ or 1 unit. Prerequisite: Speech 391 and 395.

395. **Audiometry.** Principles and application of basic audiometry. ½ or 1 unit. Prerequisite: Speech 391 or consent of instructor.

396. **Diagnosis of Hearing Impairments in Infants and Young Children.** Symptoms and causes of hearing impairment in young children; practice in procedures used for the measurement of residual hearing; selection and use of hearing aids. ½ or 1 unit. Prerequisite: Speech 391 and 395, or consent of instructor.

397. **Measurement of Auditory Perception.** Principles and methods of clinical assessment of auditory perception. Intensive study of measurement techniques for speech perception; applications with clinical clients; survey of current literature and research. ½ or 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Speech 391 and 395. O'NEILL.

398. **Practicum in Audiology.** Observation, practice, and research in diagnosis and rehabilitation of auditory disorders. ½ unit. Prerequisite: Speech 393. STARK.

399. **Design and Analysis of Experiments in Speech and Hearing Science.** An introduction to experimental designs and methods of statistical analysis in speech and hearing research. ½ or 1 unit. Prerequisite: Graduate standing or consent of instructor.

THEATRE

Graduate students interested in theatre should meet the requirements for the Master of Arts and Doctor of Philosophy in Speech with a theatre option. For further information, see descriptive material given under the Department of Speech, page 369.

Master of Arts. Admission requirements are a grade-point average of at least 3.5 and (1) an undergraduate major in theatre, which includes at least nine hours in dramatic literature either as part of the major or in addition to the major, or (2) any undergraduate major, which includes at least nine hours of basic courses in theatre (acting, direction, production) and seven hours in speech or dramatic literature.

Candidates who are deficient in one or more of the above requirements may be admitted provisionally to the program.

Degree requirements are a minimum of six units, including two units in history and theory and two in applied theatre; and a final written examination. A candidate may offer a research thesis for no more than two of the eight units required by the Graduate College.

Doctor of Philosophy. Admission requirements are a grade-point average of at least 4.0 in the last four semesters of undergraduate and/or graduate work and (1) an undergraduate major in theatre which includes at least nine hours in dramatic literature, either as part of the major or in addition to the major, or (2) an under-

graduate major in a related field, such as speech, English, dance, art, radio and television, with at least nine hours of course work in dramatic literature; or a Master of Fine Arts degree in theatre or a Master of Arts degree in theatre, or the equivalent, with a thesis or other evidence of research ability.

Degree requirements are a minimum of ten units in theatre courses, exclusive of thesis research, and a minor of four units in one or two of the following areas: history, history of art, dramatic literature (in English or the foreign language departments), philosophy, speech.

GRADUATE FACULTY

Professors: B. Hewitt (Chairman of Department), Clara M. Behringer, J. W. Scott, C. H. Shattuck.

Associate Professors: Mary H. Arbenz, Genevieve Richardson, W. L. Smalley, B. R. Works.

COURSES FOR GRADUATES

400. **Seminar in Dramatic Form and Structure.** Studies in the relationship of dramatic form and structure to the contemporary production of historical and modern plays. 1 unit. Prerequisite: Speech 361 and 362, or equivalent; consent of instructor. Smalley.

451. **Problems in Play Directing in the Educational Theatre.** Same as Speech 451. Study of the audience, play selection, the actor's abilities and needs, tryouts and casting, conduct of rehearsals and methods of directing, the dramatic club, contests and festivals. 1 unit. Behringer.

452. **Problems in Play Production in the Educational Theatre.** Same as Speech 452. Study of the school auditoria and stages, stage machinery and equipment and their use, lighting facilities and their use, organization of backstage crews, scene shifting and stage management, production problems of special types of plays. 1 unit. Behringer.

461. **Advanced Theatre Techniques.** Individual development of advanced techniques of acting and staging through supervised participation in public productions. ½ or 1 unit. Prerequisite: At least one semester of graduate study in the area of theatre; consent of head of department and of instructor.

463. **Seminar in the History of Acting.** Studies in the history and theory of the art of acting. 1 unit. Students may accumulate maximum credit of two units. Offered in 1969-1970 and in alternate years. Arbenz.

465. **Seminar in Theatre Art.** Studies in the aesthetics of the theatre. 1 unit. Hewitt.

466. **The American Theatre Since 1900.** Major developments in acting, production, playwriting, organization, and operation. 1 unit. Behringer.

468. **Seminar in Theatre History.** Studies in the history of the theatre. 1 unit. Hewitt.

469. **The Stage History of Classic English Plays.** Same as Speech and English 469. Analysis and reconstruction of past productions of classic plays, with special reference to Shakespeare. 1 unit. Prerequisite: One year of work in dramatic literature or theatre history; consent of instructor. Shattuck.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

351. **Styles of Acting for Period Plays.** Study and practice of traditional styles of acting in dramas by important playwrights representing major theatrical eras such as Sophocles, Aristophanes, Shakespeare, Racine, Moliere, Congreve, Wilde. Lectures, demonstrations, exercises, performance. ½ unit. Prerequisite: Theatre 261 or consent of instructor. Arbenz.

352. **Introduction to Modern Theatre Art.** Same as Speech 352. Origins and development of modern theatrical production; a critical examination of contemporary ideas and practices in theatre architecture, acting, directing, and staging. ½ or 1 unit. AHART.

353. **Creative Dramatics for Children.** A study of the subject matter and techniques of creative dramatics for children, with laboratory application. ½ or 1 unit. Prerequisite: Consent of instructor. TYMCHYSHYN.

354. **Theatre for the Child Audience.** A study of the history, objectives, and techniques of play production for the child audience, with laboratory application. ½ or 1 unit. Prerequisite: Consent of instructor. TYMCHYSHYN.

361. **History of the European Theatre to the Renaissance.** Same as Speech 361. The theatre and the theatre arts of ancient and of medieval Europe. ½ or 1 unit. SCOTT.

362. **History of the European Theatre from the Renaissance to 1900.** Same as Speech 362. The European theatre and the theatre arts from 1576 to 1900, with special reference to the English theatre. ½ or 1 unit. SCOTT.

366. **Development of the American Theatre.** Same as Speech 366. The development of the theatre and of theatre arts in America from colonial times to the beginning of the twentieth century. ½ or 1 unit. ARBENZ.

368. **History of Theatre Costume.** A survey of the history of costumes worn on the stage from the classical Greek period to the present. ½ or 1 unit. Prerequisite: Theatre or Speech 361 and 362, or consent of instructor. RICHARDSON.

370. **Stage Scenery Design.** Theory and practice of designing stage scenery. ½ or 1 unit. Prerequisite: Theatre 120 or Speech 157 and two of the following: Theatre 255, 352, 361, 362, or consent of instructor. WORKS.

380. **Advanced Dramatic Writing.** Same as Speech, English, and Radio and Television 363. Application of principles of dramatic form and structure to the more complex problems of playwriting. Practice in writing sustained dramatic forms. ½ or 1 unit; students may accumulate 2 units of credit. Prerequisite: Theatre 280 or equivalent; consent of instructor. SMALLEY.

381. **Directing, II.** Production problems and techniques of movement and business for non-proscenium staging areas; direction of appropriate scenes for class presentation; study of production practices for the musical play. ½ unit. Prerequisite: Theatre 281.

THEORETICAL AND APPLIED MECHANICS

The Department of Theoretical and Applied Mechanics offers work leading to the Master of Science and Doctor of Philosophy.

Graduate students electing theoretical and applied mechanics as their major usually have a bachelor's degree in engineering. Students having a bachelor's degree with a major in mathematics, computer science, engineering physics, engineering science, and similar areas, who have had the equivalent of the undergraduate courses usually required for the bachelor's degree in engineering, however, may also elect to major in theoretical and applied mechanics. Admission requires a 4.0 grade-point average for the last sixty semester hours of work completed in terms of a five-point scale (A = 5.0). Applications of students with grade-point averages below 4.0 but above 3.74 are considered on an individual basis.

Candidates for the Doctor of Philosophy are required to take, in addition to the thesis, at least one-half unit from each of the following areas in the department: (1) applied mathematics, (2) dynamics and vibrations, (3) fluid mechanics, (4) me-

chanics of solids, (5) materials engineering. A student majoring in one of these areas may elect a second minor in one of the other areas, providing the first minor is outside the department.

The course prerequisites for a minor in theoretical and applied mechanics are, in general, the same as for a major, but with certain modifications depending on the student's interests and objectives. The course requirement for a minor for the Master of Science is one unit; for the Doctor of Philosophy, the requirement for a sole minor is four units and for a second minor, two units.

The department has strong programs in the five areas noted below.

Dynamics. An understanding of the response of a mechanical system to a dynamic environment is basic to the analysis and design of many mechanical systems. Major areas of research include kinematics and kinetics. Research in kinetics usually involves deformable bodies, fluids, and materials behavior. Irregular or random type loading on deformable bodies has been the subject of much research. A statistical approach to the latter problem has made it possible to predict the probability of finding response of a system within a certain range.

Fluid Mechanics. This study concentrates on the fundamental phases of fluid behavior with particular regard to the manner in which fluids flow in technological applications. Both gas and liquid motions are considered. Recent studies have centered on turbulence and boundary layer theory and into laminar viscous flows of physiological systems, including simulation of cerebral circulation problems. Body flow is being studied in the low Reynolds number range, where fluid inertia effects are appreciable and such factors as wave reflections, head loss, and flow stability at conduit branches are important.

Mechanics of Deformable Bodies. This study concerns load carrying members or structures that are subjected to various types of loads and to various temperature environments. Methods of analysis follow two distinct phases, experimental or analytical, although the two phases often complement each other. Some experimental research involves two- and three-dimensional photoelasticity, reflective photoelastic coating, brittle coating, foil and semi-conductor strain gages, Moire method, and displacement transducers. The analytical phase consists of mathematical theories such as elasticity, elastic stability, plasticity, and viscoelasticity.

Behavior of Engineering Materials. Emphasis is placed both on an understanding of the fundamental factors that control deformation and fracture of materials. Research encompasses studies of metals and nonmetals (including concrete, plastics, glass, and composites) and includes the inherent influence of environment on the mechanical behavior of materials in current and future engineering applications. Research is characterized by study of "analysis models" the results of which are combined with the data from a limited number of experiments to predict the performance of a structural or machine part in service.

Major in Applied Mathematics. Graduate students in theoretical and applied mechanics also may major in applied mathematics. See mathematics (applied), page 285. The student takes at least one-half his work in one or more of the following areas: dynamics, fluid mechanics, material engineering, or mechanics of deformable bodies.

GRADUATE FACULTY

Professors: T. J. Dolan (Head of Department), A. P. Boresi, C. E. Bowman, M. E. Clark, H. T. Corten, R. A. Eubanks, P. G. Jones, C. E. Kesler, H. L. Langhaar, W. M. Lansford, J. Morrow, J. M. Robertson, O. M. Sidebottom, G. M. Sinclair, J. O. Smith, M. C. Stippes, C. E. Taylor, H. R. Wetenkamp, W. J. Worley.

Associate Professors: A. C. Bianchini, G. A. Costello, R. E. Miller, J. W. Murdock.

Assistant Professors: F. Bauling, D. E. Carlson, R. S. Jensen, J. L. Lott, L. K. Shirely, J. C. Wiley.

COURSES FOR GRADUATES

400. **Seminar in Engineering Mechanics.** There are many special topics in the field of mechanics such as fracture of metals, creep of materials, etc., in mechanics of solids; fluid flow problems such as the nature of turbulence, boundary layer theory, nature and effects of roughness of boundary, effects of free surface; dynamics problems such as vibration of beams with moving loads, the gyroscope, etc. Such special topics as these are covered in this course. Each semester one or more of these topics is selected and announced as the area to be covered in this course during that semester. ¼ unit. Staff.

412. **Vibration Analysis.** Continuation of Theoretical and Applied Mechanics 311. Specific topics are systems of several degrees of freedom; applications of generalized coordinates and Lagrange's equations; boundary value problems in vibration of elastic bodies, including strings, rods, and beams; Stodola's method; iteration process and matrix procedure; vibrations in reciprocating machines, airplane structures and propellers; impact and transient vibrations; self-excited vibration; stability; nonlinear systems. 1 unit. Prerequisite: Theoretical and Applied Mechanics 311 or equivalent. Jones.

416. **Energy Principles in Engineering Mechanics.** Designed to introduce the student to the variational principles of mechanics and their applications to engineering problems. The derivation, interpretation, and applications of the principle of virtual displacements, the principle of minimum potential energy, the principle of complementary energy, Castigliano's theorem, Hamilton's principle, and Lagrange's equations of motion constitute the main part of the course. Variational methods of approximation are treated briefly. The material includes numerous illustrative applications to stress analysis of statically determinate and statically indeterminate frames, problems of elastic stability, the theories of rings and curved beams, the theory of elastic plates, vibrations of structures, and wave motions. 1 unit. Prerequisite: Theoretical and Applied Mechanics 451. Boresi, Langhaar, Taylor.

424. **Properties of Engineering Materials.** Structure of metals and behavior of materials under various conditions of loading and use, including static, creep, fatigue, and impact; effects of high and low temperature, strain rate, state of stress, and internal structure; criteria of failure; relation of mechanical properties to behavior; significance of mechanical properties; tests and interpretation of test data; material specifications. ½ or 1 unit. Corten, Sinclair.

425. **Mechanics of Inelastic Bodies.** The course presents methods of obtaining relations between loads, deformations, stresses, and strains in various members that are stressed beyond the elastic range. Most applications consider both time-independent and time-dependent (creep) inelastic deformations. Some specific topics are straight and curved beams, columns and beam-columns, fully plastic analysis of statically indeterminate members and structures, torsion of circular and noncircular bars, and torsion-tension of bars of circular cross-section. ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 321. Sidebottom, Smith.

426. **Stress and Deformation in Engineering Components.** Continuation of Theoretical and Applied Mechanics 321: energy principles, forces and moments in plane and three-dimensional indeterminate members; beams on elastic support; flat plates, thick-walled cylinders, rotating disks, including temperature stresses; contact stresses and deflections; values and significance of stress concentrations. ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 321 or equivalent. Sidebottom, Smith.

427. Theories of Mechanical Properties and Behavior of Plain Concrete. Theories used in the design of concrete and the factors affecting the properties and behavior of the material and of the test piece. Behavior of plain concrete under different types of environment and of loading, such as long time, repeated, and tri-axial, are emphasized. The studies involve critical reviews of experimental and analytical investigations. ½ to 1 unit. Prerequisite: Bachelor Science in engineering. KESLER, LOTT.

428. Analysis of Nonlinear Systems. Same as Electrical Engineering 428. Singular points and stability considerations are treated. Graphical and analytical methods including the perturbation method, variation of parameters, Galerkin's method, and the Ritz method for solving nonlinear differential equations are considered. 1 unit. Prerequisite: Mathematics 341; consent of instructor. WORLEY.

431. Theory of Ideal Fluid Flow. Together with Theoretical and Applied Mechanics 432, topics in advanced fluid mechanics are covered that are the basis of many modern developments. Ideal fluid theory is concerned with an incompressible fluid of negligible viscosity. The differential equations of motions are derived and the several methods of obtaining flow solutions are presented: the obtaining of velocity potentials and stream functions by superposition of the effects of source, doublets, and vortices, and by the methods of conformal mapping. Relations for finding the resultant forces and moments on bodies are derived and applied to bodies such as lifting surfaces. Other topics covered include the theory and application of free streamline flows, vortex motions, and surface wave theory. 1 unit. Prerequisite: An elementary course in fluid flow; a course in advanced calculus. ROBERTSON, SHIRELY.

432. Theory of Flow of Viscous Fluids. Although a logical continuation of Theoretical and Applied Mechanics 431, this course need not be taken sequentially. Concerned with the theoretical development, analysis, and solution of incompressible viscous fluid flow problems. Starting with the stress relations occurring in viscous fluids, the differential equations of motion are derived and direct and approximate solutions for laminar flows are developed. Boundary-layer theory is presented and the occurrence of turbulence and its characterization introduced. The basic equations for analyzing turbulent flows are introduced and approximate solution for flows in boundary-layers with and without pressure gradients (and separation) pipes and jets are presented. Includes consideration of experimental observation and application to technological problems. 1 unit. Prerequisite: An elementary course in fluid flow; a course in differential equations. ROBERTSON, SHIRELY.

438. Turbulence. Starting with the statistical modes of characterizing turbulence, discussion covers statistical theory, energy considerations, and nature of turbulence in typical flows. Laboratory experiments are used to illustrate hot wire technique of turbulence measurements and the structure of turbulence. 1 unit. Prerequisite: Theoretical and Applied Mechanics 432 or equivalent. ROBERTSON.

441. Applied Analysis in Engineering. A course to provide training in applications of mathematics to engineering problems. Most of the illustrations are taken from engineering mechanics. 1 unit. Prerequisite: Mathematics 143; Mathematics 343 and 345 are recommended. COSTELLO, LANGHAAR, MILLER.

442. Applied Analysis in Engineering. Continuation of Theoretical and Applied Mechanics 441. 1 unit. Prerequisite: Mathematics 143; Mathematics 343 and 345 are recommended. COSTELLO, LANGHAAR, MILLER.

451. Theory of Elasticity with Application to Engineering Problems. A study of the mechanics of elastic deformable bodies, based on the fundamental concepts of equilibrium, geometry of strain, and properties of materials. Relations between stresses, strains, and displacements are studied in detail with special consideration

given to their significance in engineering problems. 1 unit. Prerequisite: Theoretical and Applied Mechanics 221; Mathematics 343; Mathematics 341 or equivalent. Boresi, Eubanks, Langhaar, Miller, Taylor.

452. **Theory of Elasticity with Application to Engineering Problems.** Continuation of Theoretical and Applied Mechanics 451. 1 unit. Prerequisite: Theoretical and Applied Mechanics 451. Boresi, Langhaar, Stippes.

454. **Theory of Shells.** A course designed to provide the theoretical basis of stress analysis of shell-type structures, such as ships, submarines, monocoque aircraft structures, concrete roofs and domes, pressure vessels, and containers for liquids. The material includes the differential geometry of shell theory, equilibrium equations, momentless theory of shells, strains in shells, statically indeterminate problems of shells, energy formulations, and stability of shells. 1 unit. Prerequisite: Theoretical and Applied Mechanics 451. Boresi, Langhaar.

457. **Classical Elastostatics.** A modern unified treatment of the concepts and techniques developed in the course of investigation of the Cauchy-Navier equations. Emphasis on the interpretation and motivation of ideas and their interrelation for the solution of three-dimensional problems. Topics include the classical boundary-value problems, existence and uniqueness theorems, stress functions and displacement potentials, singular states of stress, extension of Green's method to the equations of elasticity, method of series, and approximation techniques. Course represents a preparation for (1) students interested in the current state of knowledge in classical elasticity, and (2) students intending to do doctoral dissertations in classical elasticity. 1 unit. Prerequisite: Theoretical and Applied Mechanics 451 or equivalent; consent of instructor. Stippes.

458. **Wave Motion in Continuous Media.** An analysis of the dynamics of deformable bodies with a major emphasis on elastic media. Introduces the terminology associated with and the methods for treating such problems. Includes a general discussion of the motion of strings, bars, shafts, plates, and other bodies when subjected to load. Detailed examination of approximations involved is made and their engineering significance is discussed. 1 unit. Prerequisite: Theoretical and Applied Mechanics 311, 314, 451; Mathematics 341, 342, 343, or equivalent. Eubanks, Stippes.

460. **Continuum Mechanics.** Foundations of the general (nonlinear) theories of continuum mechanics. A brief introduction to the tensor calculus is followed by a thorough discussion of the theory of deformation and motion of continua. The stress principle of Cauchy and the basic principles of classical mechanics, i.e., balance of momentum, moment of momentum, and energy, are discussed. A general treatment of constitutive relations is followed by detailed examination of some examples for two particular materials, the elastic solid and the stokesian fluid. 1 unit. Prerequisite: Theoretical and Applied Mechanics 351 or equivalent. Carlson.

462. **Theory of Plasticity.** The physical and mathematical formulation of the mechanics of inelastically deformed bodies, plastic stress-strain laws, and their association with yield and loading function. Deals primarily with members subjected to bi-axial and tri-axial stress conditions. Specific topics include applications to flexure and torsion of prismatic members; expansion of thick-walled cylinders and spherical shells; introduction to problems in plane plastic flow and variational plasticity. ½ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 451 or equivalent. Sidebottom.

464. **Theory of Buckling.** The pertinent information and theoretical background required for the prediction of failure by buckling of structures such as airplanes, ships, bridge trusses, fabricated towers and shells; practical illustrations. Specific topics are elastic columns with various end restraints; buckling of frameworks, arches, rings, and plates; inelastic buckling of columns and plates; lateral buckling

of beams; energy theory; Ritz procedure; Euler's equation of the calculus of variations. ½ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 416 and 451. COSTELLO, LANGHAAR.

467. Thermomechanics of Nuclear Reactor Systems. Same as Nuclear Engineering 467. Origin of thermomechanics problems in nuclear reactor systems; heat generation and transfer in nuclear power systems; thermal stress in nuclear reactor systems; dynamical theory including effects of thermal-shock and thermal stress-wave propagation; current thermo-mechanics problems in nuclear reactor design. Term paper required. 1 unit. Prerequisite: Nuclear Engineering 401 or consent of instructor. BORESI.

472. Advanced Photoelasticity. Theoretical and practical aspects of modern photoelasticity. Topics include: three-dimensional photoelasticity, birefringent coatings, dynamic photoelasticity, photoplasticity, photoviscoelasticity, and photothermoelasticity. 1 unit. Prerequisite: Theoretical and Applied Mechanics 326, 451, or consent of instructor. TAYLOR.

493. Advanced Independent Study (Special Problems). Analytical or experimental studies in one or more phases of theoretical and applied mechanics, including mechanics of materials, theory of elasticity, theory of plasticity, properties of materials, mechanical vibrations, hydraulics and fluid mechanics, fatigue of metals, etc. ½ to 2 units. STAFF.

499. Thesis Research. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. Mechanical Vibrations. Kinematics of vibratory motion; comprehensive study of motion having single degree of freedom; critical speeds of shafts; vibration of systems with several degrees of freedom. Applications to engineering problems. ½ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 154, or 156 or 211 or 212 and 221.

314. Advanced Dynamics for Engineers. Three-dimensional kinematics of a rigid body, general dynamics of a rigid body, moments and products of inertia, kinetic energy, rotation of a rigid body about a fixed axis and about a fixed point, Euler equations of motion, gyroscopic theory; introduction to Lagrange equations; engineering applications. 1 unit. Prerequisite: Theoretical and Applied Mechanics 211 or equivalent; Mathematics 341 or 345.

315. Advanced Dynamics with Applications to Engineering Problems. General advanced methods of dynamics are discussed. Some emphasis is placed on the behavior of special components of guidance and control systems. Associated engineering problems are treated. Topics: Lagrange equations and Hamiltonian canonical equations; Hamiltonian methods; theory of vibrations; special theory of relativity, gyroscopic compass; gyroscopic stabilizer; modern gyroscopes; astronomical applications. 1 unit. Prerequisite: Theoretical and Applied Mechanics 314 or equivalent.

321. Advanced Mechanics of Deformable Bodies. Basic concepts of mechanics of deformable bodies and brief review of elementary topics; theory of stress and strain at a point; theories of failure, including failure by fracture; unsymmetrical bending; curved beams; torsion of noncircular sections; energy principles; Castigliano's theorem. ½ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 221 and 223 or 224.

324. Flow and Fracture of Structural Metals. Fundamental concepts of strength of crystalline engineering materials at atomic, single crystal, and polycrystalline levels of association in relation to engineering mechanisms of failure; functional relationship between material variables, state of stress, strain, time, temperature,

and failure of engineering components by creep, stress rupture, fatigue, and brittle fracture. ¾ unit. Prerequisite: Theoretical and Applied Mechanics 221 and 224, or consent of instructor.

326. **Experimental Stress Analysis.** Measurement of stresses or deformations that are of significance in the engineering design of load-resisting members; use of optical, electrical, and mechanical instrumentation, models, analogies, brittle coatings, electrical resistance gages, photoelasticity, etc. ½ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 150, 211, 212, 221, and 223 or 224. Theoretical and Applied Mechanics 321 is desirable.

334. **Fluid Mechanics and Advanced Hydraulics.** A study of the basic properties of fluids in general, particularly those that influence the flow of fluids in pipes and open channels, viscosimetry, dimensional analysis, effect of boundary conditions, cavitation, water tunnel, hydraulic jump, water hammer, pumps, turbines. Some laboratory work. ½ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 235.

335. **Dynamics of Fluids.** An intermediate course in the mechanics of fluids, introducing analytical methods of solution for ideal and real fluids. Potential flow theory, theoretical approaches to viscous flows including boundary-layer theory, and the analysis of compressible flows are indicated. ¾ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 235.

346. **Dimensional Analysis and Theory of Models.** The nature and use of dimensions, systematic calculation of dimensionless products, algebraic theory of dimensional analysis, similarity and model laws, and derivation of model laws from differential equations. Applications include von Karman's theory of similarity in turbulent flow, boundary-layer theory, topics in open channel flow, model laws for pumps and turbines, topics in structural analysis and vibration theory, topics in the theory of heat. ½ or 1 unit.

351. **Advanced Mechanics of Continuous Media.** General theory of stress; general theory of strain, stress-strain relationships; plane theory of elasticity; advanced topics in bending and torsion. 1 unit. Prerequisite: Theoretical and Applied Mechanics 221; Mathematics 343; a course in differential equations.

373. **Engineering Acoustics.** Same as Electrical Engineering 373. Development of the basic concepts needed for the understanding of mechanical and electric acoustic systems: vibrating string, vibrating membrane, plane waves, spherical waves, vibrating piston, accoustical filters, loudspeakers and microphones, principle of reciprocity, the ear, architectural acoustics. ¾ or 1 unit. Prerequisite: Mathematics 345 or equivalent, or consent of instructor.

392. **Analysis and Synthesis of Problems.** This course emphasizes the rational analysis of comprehensive problems and engineering systems. ½ or 1 unit. Prerequisite: Consent of instructor.

URBAN PLANNING

The Department of Urban Planning offers work leading to the master's degree. Students applying for admission must have a grade-point average of at least 3.75.

Master of Urban Planning. College graduates in liberal arts and sciences as well as architecture, urban planning, civil engineering, and landscape architecture can prepare themselves for careers in city, state, and regional planning.

The graduate program typically requires two years in residence, but a student with an undergraduate degree in urban planning may complete the program in a shorter period.

To qualify for this degree, a student must take (1) the seminar and thesis courses for at least two units, (2) a total of at least six units of urban planning, and (3) at least two additional units to be chosen from the following fields: architecture, civil engineering, economics, geography, landscape architecture, political science, or sociology.

GRADUATE FACULTY

Professors: W. I. Goodman (Chairman of Department), J. M. Heikoff, S. Keyes, L. B. Wetmore.

Associate Professors: L. F. Blair, E. C. Freund, A. Z. Guttenberg, W. B. Hansen, J. R. Voss.

COURSES FOR GRADUATES

437. Advanced Urban Planning Studio. Analysis and synthesis problems related to design and development programming for cities, metropolitan areas, and urban regions. 1 to 2 units. Prerequisite: Urban Planning 337, 338, and 374, or consent of instructor.

487. Seminar. ½ unit. Prerequisite: Urban Planning 374.

488. Urban Planning Research. Individual and group instruction in the application of professional competences in urban planning to the analysis of urban development problems and to the formulation of approaches to solution of such problems. ½ to 2 units. Prerequisite: Urban Planning 171 or consent of instructor.

492. Seminar on Models for Directed Change. Same as Sociology and Social Work 492. Construction and analysis of models for planned intervention at the personal, small group, and community levels. Construction of models as interpretations of behavioral science theory; extrapolating of hypotheses and of guides to intervention from the models. Readings from several disciplines as relevant. ½ or 1 unit. Prerequisite: Consent of instructor.

499. Thesis Research. ½ to 2 units. Prerequisite: Graduate standing in urban planning. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

337. Urban Planning Studio, II. The theory and development of the planning process as it applies to the study of an existing community, including visual surveys, data collection and analysis, "momentum projections," plan making, and implementation programs. 1 to 1½ units. Prerequisite: Urban Planning 236 or consent of instructor.

338. Urban Planning Studio, III. Contemporary theories of urban design and structure; planning and design of new communities; circulation and public facilities systems; studies of alternative patterns of growth. 1 to 1½ units. Prerequisite; Urban Planning 337 or consent of instructor.

351. History of Urban Planning. Description and analysis of the development of urbanization and the planning of communities from ancient times to the present, as related to environmental and cultural influences. ½ unit. Prerequisite: Urban Planning 171 or consent of instructor.

374. Urban Planning Theory. An examination of the urban planning function within a theoretical, methodological, institutional, and professional context. ½ unit. Prerequisite: Urban Planning 171 or consent of instructor.

376. Planning Analysis. Research and analytic techniques in urban planning; economic base and employment, population, market analysis; derivation and use of statistical data. ½ unit. Prerequisite: Urban Planning 171 or consent of instructor.

377. **Comprehensive Planning Procedure.** Design and plan-making techniques in urban planning; land use, circulation and community facilities; the development of the comprehensive general plan. ½ unit. Prerequisite: Urban Planning 171.

378. **Planning Legislation and Administration.** Legal tools of planning, zoning, subdivision regulations; housing codes; methodology and application; administrative procedures; the place of planning in the structure of governments; the capital improvement program. ½ unit. Prerequisite: Political Science 150, 151, or 305, 306, or consent of instructor.

380. **Survey of Regional Planning.** Concepts and procedures for planning of regions: river valley, metropolitan, state, and national planning. ½ unit. Prerequisite: Urban Planning 171 or consent of instructor.

382. **The Language and Thought of Urban Planning.** The nature of urban planning thought; the meaning of its basic terms and concepts; the philosphic issues and choices of meaning facing the future professional; trends of thought in urban planning literature. ½ unit. Prerequisite: Consent of instructor.

384. **Urban Design and Planning Methods.** Concepts and techniques of urban analysis, plan making and implementation essential for effective interdisciplinary work in urban design; case studies of major types of large-scale projects. ¾ unit. Prerequisite: Urban Planning 171 or consent of instructor.

VETERINARY MEDICAL SCIENCE

Candidates for the Master of Science and Doctor of Philosophy in Veterinary Medical Science must have a Bachelor of Science or a Doctor of Veterinary Medicine from a college or university approved by the University of Illinois. If they do not have a veterinary medical degree, their undergraduate training must be approved by the graduate faculty of the department as appropriate to advanced study. They must have a minimum grade-point average of 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

Areas of specialized study in veterinary medical science include anatomy, microbiology, parasitology, pathology, physiology, and pharmacology.

Students who intend to take graduate work for a Master of Science or Doctor of Philosophy in Veterinary Medical Science should include in their undergraduate program at least five hours of physics or mathematics, fourteen hours of chemistry, and fifteen hours of biological sciences.

Students planning to work toward the Doctor of Philosophy who enter the University of Illinois without previous graduate training are evaluated by the graduate faculty of the department at the end of their first year of residence in order to determine whether their progress is acceptable for work toward the doctorate. This evaluation is based in part upon an examination.

Departmental requirements for the Master of Science or Doctor of Philosophy in Veterinary Medical Science are described in a pamphlet which may be obtained from the office of the Dean of the College of Veterinary Medicine.

GRADUATE FACULTY

Professors: C. A. Brandly (Dean of College of Veterinary Medicine), P. D. Beamer, L. E. Boley, P. R. Fitzgerald, H. W. Hannah, L. E. Hanson, H. J. Hardenbrook, R. D. Hatch, W. G. Huber, R. H. Kokernot, N. D. Levine, R. P. Link, J. E. Lovell, M. Ristic, L. E. St. Clair, A. G. Schiller, D. Segre, P. H. Silverman, J. Simon, A. M. Watrach, G. T. Woods.

Associate Professors: D. H. Ferris, L. C. Helper, A. H. Killinger, J. P.

MANNING, W. L. MYERS, W. M. NEWTON, F. E. ROMACK, A. H. SAFANIE, E. SMALL, A. R. TWARDOCK.

Assistant Professors: J. J. B. ANDERSON, C. D. KNECHT, R. C. MEYER, H. E. RHOADES.

Instructor: DIANE K. NORMANDIN.

COURSES FOR GRADUATES

408. Principles of Hematology. The cellular morphology of the blood and bone marrow of animals in health and disease. Lectures, discussions, demonstrations, and laboratory. ½ unit. Prerequisite: Veterinary Medical Science 301 or equivalent, or consent of instructor. ST. CLAIR.

415. Mechanisms of Microbial Infections. Concepts of host-microorganism relations with emphasis given to the dynamics of microorganisms and pathogenesis of specific infections. 1 unit. Prerequisite: Microbiology 326 or Veterinary Medical Science 332, or equivalent. HANSON, RISTIC.

416. Epizootiology. Principles and problems of epizootiology with special consideration of the zoonoses; ecology of the host and parasite as related to resistance, adaptation, perpetuation, and distribution; the principles and factors in interference, carrier and latent states, reservoirs and control. 1 unit. Prerequisite: Veterinary Pathology and Hygiene 331, Veterinary Medical Science 332, or equivalent, or consent of instructor. BRANDLY, FERRIS, KOKERNOT, LEVINE.

417. Medical Mycology. Study of the fungi that cause infections in man and animals; taxonomy, methodology, epidemiology, pathology, and diagnosis. 1 unit. Prerequisite: Microbiology 326, Veterinary Medical Science 332, or equivalent. RHOADES, WATRACH.

418. Concepts and Topics in Immunology. Newer concepts and theories in the field of immunology, including theories of antibody formation, transplantation immunity, hypersensitivity, and disturbances of the antibody-forming mechanism. Lectures and discussion. ½ unit. Prerequisite: Microbiology 327 or equivalent; consent of instructor. SEGRE.

425. Experimental Parasitology. Same as Zoology 425. A broadly based consideration of the relation of parasites to their hosts and to their environments, and of the factors which influence these relationships. 1 unit. Prerequisite: A laboratory course in parasitology or protozoology; organic chemistry; Chemistry 350; biochemistry and statistics are recommended. FITZGERALD, LEVINE, SILVERMAN.

440. Design and Analysis of Biological Experiments, I. Same as Agronomy, Animal Science, Dairy Science, Forestry, and Horticulture 440. A study of statistical methods as tools for research. Principles of designing experiments and the methods of analysis for various kinds of designs are considered from the viewpoint of when and how to use the available simpler designs and analytical methods. 1 unit. Prerequisite: Consent of instructor.

441. Design and Analysis of Biological Experiments, II. Same as Agronomy, Animal Science, Dairy Science, Forestry, and Horitculture 441. A continuation of Veterinary Medical Science 440, moving into the more complex designs and methods of analysis. 1 unit. Prerequisite: Veterinary Medical Science 440 or equivalent.

445. Advanced Macroscopic Pathology. Concepts and interpretations of gross pathologic changes and the integration of host-parasite reactions. ½ or 1 unit. Prerequisite: Veterinary Medical Science 334 and 335, or equivalent; consent of instructor. BEAMER, SIMON.

450. Advanced Veterinary Pathology. Advanced study of gross and microscopic

pathology of diseases of domestic animals. 1 unit. Prerequisite: Veterinary Medical Science 335 or equivalent. BEAMER.

455. **Comparative Oncology.** A comparative study of the nature of mammalian and avian neoplasms based on general and special methods of tumor identification, classification, and experimentation. Lectures, demonstrations, and laboratory. 1 unit. Prerequisite: Veterinary Medical Science 445 and 459, or equivalent. Required course for students majoring in pathology in Department of Veterinary Medical Science. SIMON.

457. **Ultrastructural Pathology.** Ultrastructural basis of pathologic processes occurring in animal tissues and cells. Lectures, discussions, and reports. ¾ or 1 unit. Prerequisite: Zoology 430; consent of instructor. WATRACH.

459. **Advanced Correlative Pathology.** Discussion and interpretation of disease processes of domestic animals. Emphasis on the correlation of gross, microscopic, and clinico-pathologic findings with alterations of function. 0 to 1½ units. Prerequisite: Veterinary Medical Science 308, 335, 445, 450, or equivalent; consent of instructor. BEAMER, SIMON, WATRACH.

460. **Advanced Veterinary Physiology.** Advanced study of physiology, nutrition, and biochemistry as related to problems in veterinary medical science. Problems studied include white muscle disease, sweet clover disease, ketosis, hypoglycemia and digestive disturbances. Laboratory includes planning, executing, and reporting a specific course project. 1 unit. Prerequisite: Veterinary Medical Science 315, 316, or equivalent; consent of instructor. NEWTON.

461. **Advanced Veterinary Pharmacology.** Evaluation of drugs, pharmacological aspects of biological antagonisms, chemotherapy, antibiotics, chelating agents and chemical biological correlation. ¾ unit. Prerequisite: Consent of instructor. LINK.

463. **Radioisotopes in Biological Research: Principles and Practice.** Same as Animal Science and Biophysics 463. Lectures, demonstrations, and laboratory on the fundamentals of radioisotope procedures and applications in biology and medicine. ¾ unit. Prerequisite: Quantitative chemistry; one year each of mathematics, physics, biology, and/or consent of instructor. TWARDOCK.

490. **Seminar.** Required of all graduate students whose major is veterinary medical science. ¼ unit. STAFF.

491. **The Experimental Method in Veterinary Research.** Planning of experiments, use of controls, interpretation of results, sources of error, and writing the research report. ½ unit. LEVINE.

492. **Special Problems.** Basic and applied study including orientation and research on pertinent initial and continuing problems in the student's area of interest. ¼ to 1 unit. Prerequisite: Consent of instructor. STAFF.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Gross Anatomy.** Systematic and topographic study and dissection of the dog. Lectures, discussions, demonstrations, quizzes, and laboratory. 1 unit. Prerequisite: Five hours of zoology; consent of instructor. ST. CLAIR.

301. **Microscopic Anatomy.** Structure of cells, tissues, membranes, vessels, lymphoid organs, and the hollow viscera, with special reference to the domestic animal. Lectures, discussions, demonstrations, quizzes, and laboratory. 1 unit. Prerequisite: Five hours of zoology; consent of instructor. NORMANDIN, ROMACK, SAFANIE.

302. **Gross Anatomy.** Comparative study and dissection of the domestic animals with special reference to development and adaptation to function. Lectures, discus-

sions, demonstrations, quizzes, and laboratory. 1 unit. Prerequisite: Veterinary Medical Science 300 and 301, or consent of instructor. St. Clair.

303. **Microscopic and Developmental Anatomy.** Structure and development of organs and systems with comparison in different domestic animals. Lectures, discussions, demonstrations, quizzes, and laboratory. 1 unit. Prerequisite: Veterinary Medical Science 300 and 301, or consent of instructor. Safanie.

308. **Histochemistry.** Methods used in histochemical and histological analysis in animals. Lectures, discussions, demonstrations, and laboratory. ½ or 1 unit. Prerequisite: Veterinary Medical Science 301 or equivalent, or consent of instructor. Normandin.

315. **Veterinary Physiology.** Nervous system respirations, acid-base balance, urine formation, body fluids and their regulation, muscular systems. Lectures, discussions, and laboratory. 1¼ units. Prerequisite: Consent of instructor. Newton.

316. **Veterinary Physiology and Pharmacology.** Blood and lymph, circulation, digestion, metabolism, and endocrine systems. Lectures, discussions, and laboratory. 1¼ units. Prerequisite: Veterinary Medical Science 315 or consent of instructor. Newton.

318. **Pharmacology.** General principles of pharmacy and an analysis of the action of chemical agents on physiological processes. Lectures, discussions, demonstrations, and laboratory. 1 unit. Prerequisite: Credit or registration in Veterinary Medical Science 315 and 316; consent of instructor. Huber.

320. **Pharmacology and Toxicology.** Principles of drug action and an analysis of action of chemical agents on living organisms including intoxications of domestic animals. Lectures, discussions, and demonstrations. 1 unit. Prerequisite: Veterinary Medical Science 318 or consent of instructor. Huber.

332. **Veterinary Microbiology and Immunology.** Lectures, discussions, and laboratories dealing with mechanisms of infection and resistance and the properties, pathogenesis, and control of viral infection of domestic and wild animals. 1 unit. Prerequisite: Veterinary Pathology and Hygiene 331 or equivalent; consent of instructor. Hanson, Myers.

333. **Protozoan and Arthropod Parasites.** Protozoan and arthropod parasites affecting domestic animals and man. Lectures, discussions, and laboratory. ¾ unit. Prerequisite: Courses in chemistry or animal biology or both totaling twenty semester hours; consent of instructor. Fitzgerald.

334. **General Pathology.** The basic principles of pathological processes, including tissue injury and repair, circulatory and metabolic disturbances, inflammation and neoplasia. Lectures, quizzes, demonstrations, and laboratory. 1 unit. Prerequisite: Courses in histology, parasitology, physiology, and microbiology totaling twenty-five semester hours; consent of instructor. Watrach.

335. **Special Pathology.** Disease processes affecting organs and anatomic systems and those occurring in specific diseases. Lectures, quizzes, demonstrations, and laboratory. 1 unit. Prerequisite: Veterinary Medical Science 334 or equivalent; consent of instructor. Beamer.

336. **Helminth Parasites.** Helminth parasites affecting domestic animals and man. Lectures, discussions, and laboratory. ¾ unit. Prerequisite: Courses in chemistry or animal biology or both totaling twenty semester hours; consent of instructor. Fitzgerald.

369. **Introduction to Human Ecology.** Same as Anthropology, Geography, Health Education, Physiology, Sociology, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations, and physiological, psychological,

and sociological adjustments to environment, regulation of populations, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology; one year of anthropology, geography, geology, or sociology. KENDEIGH, LEVINE, SHIMKIN, STAFF.

374. **Problems in Human Ecology.** Same as Anthropology, Geography, Health Education, Physiology, Psychology, and Sociology 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multidisciplinary studies of selected current problems. 1 unit. Prerequisite: Anthropology, Geography, Health Education, Physiology, Sociology, or Zoology 369. KENDEIGH, LEVINE, STAFF.

392. **Special Problems.** Individual research on a special problem chosen in consultation with the instructor and department head. ½ unit. May be repeated for a total of one unit. Prerequisite: Registration in veterinary medical curriculum with grade-point average of 3.5 or above. STAFF.

ZOOLOGY

See descriptions and course listings under Life Sciences, page 261.

UNIVERSITY OF ILLINOIS

Where to Write

ADMISSION
Office of Admissions and Records
100a Administration Building, Urbana 61801
or
The Graduate College
330 Administration Building, Urbana 61801

CHICAGO CIRCLE
The Graduate College
P.O. Box 4348, Chicago 60680

EMPLOYMENT (Hourly)
Director, Student Employment
707-107 South Sixth Street, Champaign 61820

EXTRAMURAL CLASSES
Division of University Extension
101 Illini Hall, Champaign 61820

FELLOWSHIPS, ASSISTANTSHIPS, OTHER FINANCIAL AID
The Graduate College
330 Administration Building, Urbana 61801
or the prospective major department

FOREIGN STUDENTS (Passport, Visa Assistance)
Director, Office of Foreign Student Affairs
314 Student Services Building, Champaign 61820

HOUSING
Director, Housing Division
420 Student Services Building, Champaign 61820

MEDICAL CENTER (Medical and Dental Sciences, Nursing, Pharmacy)
The Graduate College
P.O. Box 6998, Chicago 60680

MOTOR VEHICLE AND BICYCLE REGISTRATION
Motor Vehicle Division
101 North Mathews Avenue, Urbana 61801

PUBLICATIONS
Graduate College Catalog; Time Table; Calendar;
Financial Aid for Graduate Students;
Saturday, Late Afternoon, and Evening Classes for Teachers
The Graduate College
330 Administration Building, Urbana 61801

DEPARTMENTAL BROCHURES
The prospective major department

SERVICES FOR PERMANENTLY PHYSICALLY HANDICAPPED STUDENTS
Division of Rehabilitation-Education Services
Rehabilitation-Education Center, Champaign 61820

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Veterans Educational Benefits
707-107 South Sixth Street, Champaign 61820

1969-1970

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

GRADUATE COLLEGE

UNIVERSITY OF ILLINOIS BULLETIN

UNIVERSITY OF ILLINOIS BULLETIN. Volume 66, Number 111; May 7, 1969. Published twelve times each month by the University of Illinois. Entered as second-class matter December 11, 1912, at the post office at Urbana, Illinois, under the Act of August 24, 1912. Office of Publication, 114 Altgeld Hall, Urbana, Illinois 61801.

It is the policy of the University of Illinois to afford equal educational opportunities to qualified persons regardless of race, religion, or ethnic background.

1969-1970

NIVERSITY OF ILLINOIS
T URBANA-CHAMPAIGN

GRADUATE
COLLEGE

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1968-1969

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*Awards master's degree only.

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*Urban Planning	William I. Goodman
Veterinary Medical Science	L. Meyer Jones
Zoology	Robert L. Metcalf

*Awards master's degree only.
†Awards master's degree in management only.

CALENDAR OF THE GRADUATE COLLEGE

Note: Dates for Educational Testing Service and departmental language examinations will be available some time in October, 1969.

Summer Session, 1969

June 16, Mon.-June 17, Tues. ... Graduate registration. (Authorization cards distributed on alphabetical basis.)

June 17, Tuesday ..... Instruction begins.

July 4, Friday ..... Independence Day (holiday).

July 11, Friday ..... Applications to take the Russian examination on July 25 will not be accepted in Graduate College Office after this date.

July 11, Friday ..... Last day to add a course or to change credit from units to hours or from hours to units.

July 21, Monday ..... Last day to drop a course.

July 25, Friday evening ..... Russian examination.

July 28, Monday ..... Last day for candidates for the master's degree in August to submit theses to Graduate College Office for approval of format.

August 4, Monday ..... No names will be added to the August graduation list after this date.

August 7, Thursday ..... Last day for candidates for the master's degree in August to deposit theses.

Aug. 8, Fri.-Aug. 9, Sat. ..... Summer session examinations.

August 29, Friday ..... Last day for candidates for the master's degree in October to submit theses to Graduate College Office for approval of format.

September 5, Friday ..... Last day for candidates for the doctoral degree in October to submit theses to Graduate College Office for approval of format.

September 15, Monday ..... Last day to file application for the master's degree in October.

September 22, Monday ..... Last day for candidates for the master's degree in October to deposit theses.

September 22, Monday ..... Last day for finals for the doctoral degree in October.

September 29, Monday ..... Last day for candidates for the doctoral degree in October to deposit theses and abstracts.

Deadline Dates For Submitting Applications For Admission or Readmission in September, 1969

July 30, Wednesday ..... Last day for foreign students, who have *not* attended a college or university in the United States to apply for admission in September, 1969.

August 27, Wednesday ..... Last day for domestic students, or foreign students who have attended a college or university in the United States, to apply for admission or readmission in September, 1969.

First Semester, 1969-1970

Sept. 11, Thurs.-Sept. 13, Sat. to noon ..... Graduate registration. (Authorization cards distributed on alphabetical basis. Note: Employed school teachers registering for Saturday and evening classes should register Saturday morning, September 13. There will be no registration on Saturday, September 20.)

September 13, Saturday ..... Last day for registration without payment of late registration fine.

September 15, Monday ..... Instruction begins.

November 3, Monday ..... Last day to add a course or to change credit from units to hours or from hours to units.

November 17, Monday ..... Last day to drop a course.

November 26, Wednesday, 1 P.M. Thanksgiving vacation begins.

December 2, Tuesday, 1 P.M. .... Thanksgiving vacation ends.

December 10, Wednesday ..... Last day for preliminary examination for the Ph.D. degree if thesis credit earned during the semester is to apply to the third stage of program.

December 20, Saturday, 1 P.M. .. Christmas vacation begins.

1970

January 1, Thursday ..... Earliest date to apply for National Defense Student Loan fund for 1970-1971. (Subject to change.)

January 5, Monday, 1 P.M. ..... Christmas vacation ends.

January 5, Monday ..... Last day for candidates for the master's degree in February to submit theses to Graduate College Office for approval of format.

January 5, Monday ..... No names will be added to the February graduation list after this date.

January 12, Monday ..... Last day for candidates for the doctoral degree in February to submit theses to Graduate College Office for approval of format.

January 19, Monday ..... Last day for candidates for the master's degree in February to deposit theses.

Jan. 19, Mon-Jan. 27, Tues. .... Semester examinations.

January 26, Monday ..... Last day for finals for the doctoral degree in February.

February 2, Monday ..... Last day for candidates for the doctoral degree in February to deposit theses and abstracts.

Second Semester, 1969-1970

Feb. 5, Thurs.-Feb. 7, Sat. to noon ..... Graduate registration. (Authorization cards distributed on alphabetical basis. Note: Employed school teachers registering for Saturday and evening classes should register Saturday morning, February 7. There will be no registration on Saturday, February 14.)

February 7, Saturday ..... Last day for registration without payment of late registration fine.

February 9, Monday ..... Instruction begins.

February 13, Friday ..... Last day for application for fellowships for 1970-1971.

March 16, Monday ..... Last day to apply for National Defense Student Loan funds for 1970-1971. (Subject to change.)

March 28, Saturday, 1 P.M. ..... Spring vacation begins.

April 3, Friday ..... Last day to add a course or to change credit from units to hours or from hours to units.

April 6, Monday, 1 P.M. ..... Spring vacation ends.

April 15, Wednesday ..... Last day for preliminary examination for the Ph.D. degree if thesis credit earned during the semester is to apply to the third stage of program.

April 20, Monday ..... Last day to drop a course.

April 24, Friday ..... No names will be added to the June graduation list after this date.

May 1, Friday ..... Honors Day. Classes dismissed at noon.

May 15, Friday ..... Last day for candidates for the master's degree in June to submit theses to Graduate College Office for approval of format.

May 18, Monday ..... Last day for candidates for the doctoral degree in June to submit theses to Graduate College Office for approval of format.

May 29, Friday ..... Last day for candidates for the master's degree in June to deposit theses.

May 30, Saturday ..... Memorial Day (holiday).

June 1, Monday ..... Last day for finals for the doctoral degree in June.

June 1, Mon.-June 9, Tues. ..... Semester examinations.

June 8, Monday ..... Last day for candidates for the doctoral degree in June to deposit theses and abstracts.

June 20, Saturday ..... Commencement exercises.

Summer Session, 1970

June 22, Mon.-June 23, Tues. ... Graduate registration. (Authorization cards distributed on alphabetical basis.)

June 23, Tuesday ..... Instruction begins.

July 4, Saturday ..... Independence Day (holiday).

July 17, Friday ..... Last day to add a course or to change credit from units to hours or from hours to units.

July 21, Tuesday ..... Last day to drop a course.

August 3, Monday ..... Last day for candidates for the master's degree in August to submit theses to Graduate College Office for approval of format.

August 3, Monday ..... No names will be added to the August graduation list after this date.

August 13, Thursday ..... Last day for candidates for the master's degree in August to deposit theses.

Aug. 14, Fri.-Aug. 15, Sat. ..... Summer session examinations.

September 14, Monday ..... Last day for candidates for the master's degree in October to submit theses to Graduate College Office for approval of format.

September 14, Monday ..... No names will be added to the October graduation list after this date.

September 16, Wednesday ..... Last day for candidates for the doctoral degree in October to submit theses to Graduate College Office for approval of format.

September 28, Monday ..... Last day for candidates for the master's degree in October to deposit theses.

September 28, Monday ..... Last day for finals for the doctoral degree in October.

October 5, Monday ..... Last day for candidates for the doctoral degree in October to deposit theses and abstracts.

Deadline Dates For Submitting Applications For Admission or Readmission in September, 1970

July 29, Wednesday ..... Last day for foreign students who have *not* attended a college or university in the United States to apply for admission in September, 1970.

August 26, Wednesday ..... Last day for domestic students, or foreign students who have attended a college or university in the United States, to apply for admission or readmission in September, 1970.

The Graduate College

The University of Illinois has its oldest and largest campus at Urbana-Champaign, a community of 108,000 located 128 miles south of Chicago. Originally, it was established as the Illinois Industrial University, on the basis of the Land Grant College Act, by Governor R. J. Oglesby in 1868. The University opened its door with three full-time faculty members and fifty students. Now, one hundred years later, the total enrollment in the various branches of the University—the Graduate College and undergraduate colleges at Urbana, the Graduate College and professional colleges at the Medical Center, Chicago, and the Graduate College and undergraduate colleges at Chicago Circle—exceeds 45,000. The combined faculty and staff includes the full-time equivalent of more than 16,000 members.

The Graduate College of the University of Illinois at Urbana-Champaign offers instruction leading to advanced degrees in over one hundred fields of learning. Graduate enrollment currently exceeds 8,000 students who represent every state and eighty-eight foreign countries. Today, a graduate faculty of nearly 1,800 implements the University of Illinois Statutes which charge the Graduate College with the responsibility "to safeguard and promote standards of graduate work and to promote and assist in the development of research in all fields."

Graduate work in the medical and dental sciences, in pharmacy, and in nursing is offered in Chicago at the University's Medical Center. Inquiries concerning these programs should be directed to the Graduate College, University of Illinois at the Medical Center, 1853 West Polk Street, Chicago (P.O. Box 6998, Chicago 60680). Graduate programs in a number of disciplinary areas also are available at the University's Chicago Circle campus. Information may be obtained by writing to the Graduate College, University of Illinois at Chicago Circle, (P.O. Box 4348, Chicago 60680).

Graduate instruction offered at the Urbana-Champaign campus is listed by areas on pages 3 to 5 and is described in detail within the departmental listings, arranged alphabetically in this catalog.

The general requirements for admission and the degree requirements established by the Graduate College are described in this introductory section. All candidates for degrees must meet these requirements as well as those specified by the major departments within the departmental listings.

UNIVERSITY RESOURCES

Libraries

The University Library's resources for advanced study and research are outstanding. Its present collections now exceed 4,533,260 volumes, all but about 446,407 of them located in Urbana-Champaign. The remainder are held by the Library of Medical Sciences in Chicago and the library at Chicago Circle.

In addition to the figures for cataloged volumes cited above, the University Library contains approximately 563,500 pamphlets, 378,712 maps and aerial photographs, and 320,185 music scores and parts. More than 20,000 periodicals and newspapers are currently received.

Outstanding collections have been developed for a variety of fields. In the humanities, strong areas include classical literature, history, and archaeology; sixteenth- and seventeenth-century English literature, especially the Milton-Shakespeare period; eighteenth-twentieth century English literature, American humor and folklore; French, Italian, and Spanish literature; German literature of the sixteenth and seventeenth centuries; and comparative philology. In the fine arts, collections in architecture, landscape architecture, and music are noteworthy.

In the social sciences, the Library's holdings are significant for western United States history, Abraham Lincoln and the Civil War, Latin-American history of the Revolutionary period, Italian history, medieval and modern European history, German history from 1830-1900, Irish history, Slavic history and literature, international law and relations, political science, law, economics, labor and industrial relations, and education.

For science and technology, collections of high rank are held in mathematics, chemistry, biological sciences (especially parasitology, entomology, and ornithology), physics, geology, engineering, and agriculture.

The Library's bibliographical facilities comprise a general catalog of more than 6,000,000 cards, printed catalogs of libraries, e.g., the Bibliothèque Nationale, British Museum, and Library of Congress; national and trade bibliographies of all countries for which such works have been issued; bibliographies of special subjects; and similar aids.

A number of departmental and divisional libraries are maintained. Following are the principal collections in the main library building: Classics, Commerce, Education and Social Science, English, History and Philosophy, Human Relations Area Files, Library Science, Map

and Geography, Modern Language, Newspaper, Physical Education, Rare Book Room, and Undergraduate Library.

Elsewhere on the campus are the following departmental libraries: Agriculture, Architecture and Fine Arts, Biology, Ceramics, Chemistry, City Planning, Engineering, Geology, Home Economics, Journalism and Communications, Labor and Industrial Relations, Landscape Architecture, Law, Mathematics, Music, Natural History Survey (entomology and other biological sciences), Physics, and Veterinary Medicine.

Further facilities available for graduate students are the general bookstacks, housing about 2,500,000 volumes, and over 300 carrels in the bookstacks, assigned to individuals engaged in extended study and research. Interlibrary loan service from other institutions is provided for those engaged in research for dissertations.

Special Laboratory Facilities

Children's Research Center. The Children's Research Center, which was opened in late 1966, is a two-storied building of 25,000 square feet of offices and laboratories. Situated on the south edge of campus, it shares a site with the Adler Zone Center operated by the State of Illinois Department of Mental Health. Patients from the Adler Center, which serves an eighteen-county area in East Central Illinois, often participate in research projects conducted at the Children's Research Center.

The Children's Research Center contains laboratories specializing in research on children in such areas as psychophysiology, motor performance and play research, attention and memory, speech development and speech compression, infant attention and learning, psychopharmacology, and learning disabilities. In addition, four normal nursery school classes of children are conducted in the building, and the children are available for participation in research. Satellite facilities for research with children, operated by the Children's Research Center, are located in neighboring public schools and state institutions. Several trailer laboratories are used by the staff in conducting research on the site at public schools.

Coordinated Science Laboratory. The Coordinated Science Laboratory, an interdisciplinary laboratory in the College of Engineering, has facilities generally available to its own staff and students, and to other staff and students by special arrangement. These include a computer graphics terminal connected to a Control Data Corporation 1604

computer, a Michielson far-infrared interferometer (Research and Industrial Instruments Company Fourier Spectrophotometer), and a Jarrell Ash Vacuum Scanning Spectrometer (1200 angstroms to 62,000 angstroms). In the shop area, special facilities include an electron beam welder, two electrical discharge machines, and equipment for chemical milling and photo-fabrication.

Computer-based Education Research Laboratory (CERL). CERL has designed and is operating PLATO III, a flexible and sophisticated computer-based education (CBE) system. The system utilizes a CDC 1604 computer as the central control unit for up to twenty student terminals; all student terminals can be used independently and simultaneously. In addition to a twenty-terminal CBE classroom at CERL, there are three other classrooms located at educational institutions in the Urbana-Champaign community and one in another part of the campus. The system has been used for more than 60,000 student-contact hours of credit teaching. Some of the areas in which studies have been conducted are electrical engineering, geometry, biology, nursing, library science, algebra, mathematics drill, computer programming, and foreign languages. The PLATO III system is the predecessor for a system of 4,000 student terminals under the control of a central computer which is to be in operation in 1972-1973.

Digital Computers. See Department of Computer Science, page 148.

Electron Microscope Facility. The Electron Microscope Laboratory, located in the basement of Bevier Hall, is a central facility for instruction and research in behalf of all University departments. It is equipped with a Siemens Elmiskop 1, a highly modified Hitachi HS-6, RCA models EMU-3D, EMU-3C, EMU-2C, and EMU-2E electron microscopes, and a Cambridge Stereoscan electron microscope. Ancillary equipment includes seven ultramicrotomes, three shadowcasters, an RCA electron diffraction unit, and three complete photographic darkrooms and general facilities.

The instructional program consists of the following courses: Biology or Chemistry 423, Electron Microscopy; Biology or Chemistry 429, Electron Microscopy with Laboratory; Biology or Chemistry 493, Advanced Electron Microscopy; Biology 430, Biological Ultrastructure; and seminars and special workshops. The facilities are available for research conducted by qualified members of the faculty and graduate students.

Materials Research Laboratory. The Materials Research Laboratory supports the training of graduate students and research in the

materials sciences in cooperation with the departments of Ceramic Engineering, Chemistry and Chemical Engineering, Electrical Engineering, Mining, Metallurgy, and Petroleum Engineering, and Physics. Emphasis is placed on interdisciplinary research which is basic to an understanding of the solid state of matter. The Laboratory contains machine and glass shops, cryogenic facilities, high temperature, toxic materials, x-ray, electron microscope and electron microprobe laboratories, a chemical analysis laboratory with emission and mass spectrographic equipment and a 3 MEV electron accelerator.

Physical Environment Unit. The facilities of the Physical Environment Unit provide unique opportunities for pursuing interdisciplinary researches on the responses of biological systems to stresses imposed by the physical environment. An altitude chamber accommodating six human beings permits simulation of altitudes up to 45,000 feet. Air temperature and humidity may be controlled in this chamber to permit investigation of the combined stresses of low environmental pressure and heat or cold. Additional controlled environment rooms provide flexible areas where special test facilities may be installed. The Physical Environment Unit serves as the focus for teaching and research in the course sequence on ergonomics, offered jointly by the departments of Physiology and Biophysics, and Mechanical and Industrial Engineering. All departments and divisions of the University needing closely controlled environment conditions for research or instructional work may utilize the special skills and equipment available in the Unit.

Radioisotope Laboratory. The Radioisotope Laboratory is an all-University facility for graduate training and research involving the use of the tracer technique with carbon-14 or tritium or both. It is equipped with liquid scintillation spectrometers, vibrating reed electrometers, gas counters, radio-gas chromatography units, high vacuum systems, combustion set-ups, and auxiliary radiochemical equipment.

A prerequisite for research in the Laboratory is the carbon-14 course, Chemistry and Animal Science 496, which emphasizes experimental techniques employed in the synthesis, degradation, isolation, establishment of purity, and assay of radioactive carbon compounds. Members of the staff present this course one semester each year.

Social and Cultural Facilities

Students at the University of Illinois have a wide choice of activities and facilities available to them. Campus events announced in a weekly

calendar include musical programs, lectures, University forums, campus and traveling theatrical productions, weekend movies and dances, and fine arts and scientific exhibitions. The Illini Union, the campus social center, has lounges, dining facilities, and recreational and meeting rooms available to students and faculty.

The Krannert Art Museum provides galleries for displaying the University's permanent collection of art works and for presentation of other exhibitions. A University Festival of Contemporary Arts, held every two years, includes special events and exhibits in the areas of art, architecture, landscape architecture, urban planning, drama, motion picture, literature, printing, dance, and music.

The Krannert Center for the Performing Arts with its four separate and specialized theatres, provides excellent facilities for orchestra, opera, choral organizations, theatre, and dance. The professional programs in these areas are housed in the Center, which schedules numerous performances by local groups and outside organizations.

ADMISSION

General Requirements

It is recommended that prospective students apply for admission at least two months before the beginning of the term in which they expect to enroll. Applications for admission or readmission, including the application fee (see page 47) and all supporting documentation, *must be submitted* by domestic students no later than two weeks prior to registration or by foreign students at least six weeks prior to registration.

A nonrefundable deposit of $30.00 on tuition and fees is required of all *new and readmitted domestic graduate students and all foreign students who are presently residing in the United States.* (No advance deposit is required for the summer session.) This deposit should not be sent until requested by the University. Graduate students assured of the award of a fellowship, assistantship, tuition and fee waiver, or staff appointment are permitted to confirm their intention to enroll without payment of the advance deposit.

Admission forms may be obtained from the Office of Admissions and Records, 100a Administration Building, or from the Graduate College, 330 Administration Building.

An application for admission is considered if the applicant is a graduate of an institution awarding a baccalaureate degree or an equivalent degree, comparable to that granted by the University of Il-

linois, and if his scholastic record meets the minimum admission aver-
age specified by the Graduate College (3.5 on a scale where A = 5.0)
and by the proposed major department or division. Admission aver-
ages for master's candidates are computed from the last sixty semester
hours of work completed and, for doctoral candidates, the average for
the last sixty semester hours of undergraduate work and the average
for all graduate work.

In addition, faculty members in the proposed major field evalu-
ate the applicant's record. In this review, special attention is given to
the applicant's preparation for advanced study in the area. Admission
is granted only on the recommendation of the major department.
Since consideration must be given to the availability of staff and
facilities, not all who qualify for admission can be admitted.

Admission Status

A permit to enter the Graduate College, issued to each new or re-
admitted graduate student, indicates the student's status as follows:

Status No. 1: Full graduate standing at the master's level.

Status No. 2: Full graduate standing at the post-master's or doctoral
level.

Status No. 3: Limited standing. This is a probationary status for stu-
dents (1) who have less than a 3.5 grade-point average; (2) who have
departmental deficiencies to be removed during the first year; (3) who
are currently enrolled as undergraduates; (4) who present foreign cre-
dentials which must be evaluated at the time of registration.

Permits for Status 1, 2, or 3 are issued with the understanding that
the major department will determine deficiencies or prerequisites and
will advise the student with respect to his program of study.

Status No. 4: Non-degree standing. This status is limited only to
those applicants who have *no intention* of pursuing a graduate degree
at the University of Illinois. Non-degree students are advised in the
Graduate College Office, 330 Administration Building.

A student admitted or readmitted with non-degree standing for the
fall, spring, or summer term must apply for readmission for the follow-
ing September if he expects to register that term.

Physical Examination

Each new student proposing to enroll in the University of Illinois at
Urbana-Champaign for a full semester and to take more than one unit,
is required, before completion of his registration, to present adequate

evidence of satisfactory physical and mental health as determined by the Director of Health Services.

Part-time graduate students enrolling for one unit, or five hours, or less, are not required to have a physical examination except in those instances when the Director of Health Services considers the physical examination, in addition to the required tuberculin test, advisable for the protection of the health of other students.

Former and continuing students may also be required to present adequate evidence of satisfactory physical and mental health prior to readmission or registration and continuation in the University. All former students re-entering after an absence of one semester or longer are required to have the tuberculin test as a condition of registration. All students who have lived abroad for an academic year or its equivalent are required to have a complete physical examination when returning to reregister in the University.

A new student enrolling in the summer session is required to take the tuberculin test administered by the Health Service without charge as a part of the registration procedure, but is not required to take the physical examination until such time as he enrolls for a full semester. Anyone who has had a normal chest film within the past six months, and presents evidence thereof, is excused from the tuberculin test.

A complete physical examination, including chest x ray performed by the Health Service, is required of all foreign students prior to receipt of a permit to enter the University, including those foreign students whose first enrollment at the University of Illinois is in the summer session. This examination is given by the Health Service without charge.

Detailed explanatory material and medical forms for reporting the pre-entrance examination are forwarded to each student who receives a permit to enter.

Summer Session

In addition to a two-semester academic year, the University conducts an eight-week summer session at Urbana-Champaign. New students applying for admission to the Graduate College for the summer term should submit applications for admission as soon as possible after February 15, and preferably no later than May 15 preceding the first day of instruction for the summer session.

If an application for admission as a degree candidate is received after May 15, admission for the summer can be granted only for non-degree registration. Students who intend to pursue a degree but who

are admitted for non-degree registration in the summer should request consideration for degree status at the Graduate and Foreign Admissions Office, 100a Administration Building, immediately after instruction begins.

Former graduate students expecting to attend the summer session should read the following section on readmission to determine whether an application for readmission is necessary. If one is required, it should be submitted no later than May 15.

Readmission

An application for readmission must be submitted by former students if any one of the situations described below is applicable. In this context, a student who registers but later drops all of the courses he is taking that term is considered not to have registered at all. Unless otherwise stated, the situations described apply to both degree and non-degree students last registered in an extramural course as well as to those registered in campus courses.

(1) Students who did not register at any time during the previous *calendar* year.

(2) Students who wish to enroll in the fall term but were not registered *as a degree candidate* in the previous spring semester or summer session.

(3) Students who wish to register in the spring semester but were not registered in the fall term.

Former students need not apply for readmission to the summer session if they were registered the previous fall or spring or *on the campus* the previous summer. Authorization cards for registration for the summer session are prepared automatically for these students.

All students with non-degree status must apply for readmission for the fall term.

Applications for readmission to a spring or fall semester should be submitted as early as possible after October 1, and no later than two weeks before registration begins. Applications for the summer session should be filed as soon as possible after February 15.

Graduate Study by Seniors at the University of Illinois

With the approval of his undergraduate college, a senior at the University of Illinois whose academic average for his junior and senior work is 4.0 or above may apply for admission to the Graduate College if he is *within five hours* of his baccalaureate degree. If he is *within ten*

to six hours of that degree, he may apply to take some work for graduate credit. Forms describing the procedure to be followed are available at the Graduate College Office.

Foreign Applicants

Inquiries concerning admission should be directed to the Graduate and Foreign Admissions Office, 100a Administration Building, University of Illinois, Urbana, Illinois 61801, U.S.A.

The applicant must submit official records of all his higher educational training, including certificates of degrees, with the dates the degrees were conferred. These records must be certified as true copies of the originals by the proper school official of each institution attended after graduation from the secondary or high school program. The scholastic records should include by years a list of individual subjects studied and the credit and grades received for each course. If the applicant has attended school in a country following the British educational system (including India), his records must show certification of the class or division in which the degrees, diplomas, and certificates were earned. If available, a statement of the rank in class and the total number of students in the class should be included. The school records and certificates should be submitted in the language and form in which they were originally issued. If the original document is not in English, it must be accompanied by an authenticated English translation. Applicants for admission in applied art and music or architectural design are required to send samples of their work.

Eligible applicants whose native language is not English must take the Test of English as a Foreign Language (TOEFL), given several times a year throughout the world. To make arrangements to take the TOEFL, write directly to the Educational Testing Service, Box 592, Princeton, New Jersey 08540, U.S.A. If an applicant has already taken this test, he should request the Educational Testing Service to send his test score to the Graduate and Foreign Admissions Office, 100a Administration Building, University of Illinois, Urbana, Illinois 61801, U.S.A. Final admission status for those required to take the TOEFL is determined after the scores have been received. Students with unsatisfactory scores are not accepted. If the score is satisfactory, but shows a need for further English study, a placement test is required on arrival at the University. On the basis of this test, students may be required to take noncredit courses in English. These courses usually reduce a student's registration in credit courses; thus, the time to complete degree requirements is extended.

A Certificate of Eligibility for the Student (F) visa (Form I=20) is sent with a letter of admission. Usually, students who receive United States government grants or who participate in United States government-sponsored programs must obtain Exchange-Visitor (J) visas, for which a Certificate of Eligibility (Form DSP-66) is required. The Graduate and Foreign Admissions Office of the sponsoring agency sends this form, if applicable.

All foreign applicants for admission (except those in Canada and Mexico) must submit five International Postal Reply Coupons (Coupon-responsé international) of the Universal Postal Union with their applications. Usually, these coupons can be purchased at local post offices in the native country. These coupons defray some of the costs of international airmail postage incurred by the University in corresponding with applicants abroad.

FINANCIAL AID

Various types of financial assistance are available each year to promising students in all fields of study in the Graduate College. Information about qualifications and application procedures for these awards is given in the brochure, *Financial Aid for Graduate Students,* which may be obtained by writing to the Graduate College or to any of the graduate departments.

The principal kinds of awards are listed below.

Fellowships

University Fellowships. University Fellowships are awarded by fellowship committees in a competition open to students in all fields of study. The stipend for a University Fellowship is not less than $2,000 for the academic year, or $2,500 for eleven months, with exemption from tuition and all regular fees which are assessed at the time the student registers. A student receiving a University Fellowship may accept, if offered, a part-time teaching or research assistantship to a maximum of one-quarter time. University Fellows must carry a full program, normally four units or the equivalent.

Fellowships are also provided for teaching assistants for the summer session only. These awards are restricted to graduate students who have held teaching assistantships at the University of Illinois for at least half-time for both semesters of the preceding academic year, who have earned not less than two units of graduate credit during that year, and who have demonstrated superior scholarship. Fellows are se-

lected on the basis of a campus-wide competition. The Summer Fel lowships carry stipends of $500 for the eight-week summer session, plus tuition and fee exemptions.

In addition to the all-University awards, there are Fellowships in the Creative and Performing Arts. These awards are made primarily on the basis of the applicant's creative achievements and promise rather than on his academic and scholarly qualifications. Students in the fields of dance, theatre, architetcural design, landscape architecture sculpture, painting and printmaking, graphic design, industrial de sign, urban planning, and music are eligible. Applications should be directed to the appropriate department.

National Defense Graduate Fellowships. National Defense Gradu ate Fellowships are financed under Title IV of the National Defense Education Act of 1958, and are administered with the cooperation of participating universities. This program assists students who are pre paring to teach in the nation's colleges and universities. Each fellow ship, restricted to citizens or permanent residents of the United States is for a three-year period to a student beginning his graduate studies The stipend for the academic year is $2,000 for the first year, $2,200 for the second, and $2,400 for the third, plus an allowance for dependents Students who attend the summer session following the academic year may receive $400, plus dependency allotment. These fellowships pro vide exemption from tuition and all regular fees which are assessed at the time the student registers. A holder of a Title IV Fellowship may under certain conditions, also be appointed as a part-time teaching or research assistant.

Under Title VI (Modern Foreign Languages) of the National De fense Education Act, the University of Illinois participates in pro grams in Asian, Russian, and in Latin-American Language and Area Studies. These fellowships, restricted to citizens or permanent resident of the United States, are intended for students planning a college or university teaching career or other career centering on problems of the language area. The stipend for the fellowship, which is renewable, is $2,250 for the academic year, or $2,700 for the summer and academi year, plus an allowance for dependents. Title VI Fellowships also pro vide for the payment of tuition and fees.

Requests for information and application materials should be di rected to the student's prospective department.

Office of Education Fellowships. Fellowships are available in specialized areas of teacher training under the Education Profession Development Act. Fellowships may be available in various fields c

study for training teachers and other personnel for schools at all levels —pre-school through junior college and college.

A student who intends to major in a department in the College of Education should direct inquiries to the Coordinator of Graduate Study, 110 Education Building, indicating his particular field of interest. Inquiries about teacher-training programs in subject-matter fields should be directed to the student's major department.

Industrial, Endowed, Special Fellowships, and Traineeships. Various industrial firms, foundations, governmental agencies, and private individuals have generously donated funds to support special fellowships for graduate students at the University of Illinois. The stipends and supplemental allowances of these fellowships are not uniform, and most of them are restricted to students in particular areas of study.

Traineeships

National Science Foundation Traineeships. Under this program, grants are made directly to the participating institutions, which select promising individuals for NSF traineeship awards. Appointments may be made only to citizens of the United States (or native residents of a United States possession) who are enrolled in programs leading to an advanced degree in the mathematical, physical, medical, biological, or engineering sciences, anthropology, economics, geography, the history and philosophy of science, linguistics, political science, psychology, and sociology. Also included are interdisciplinary areas which are comprised of overlapping fields among two or more sciences.

The basic stipends for twelve months are $2,400 for those at first-year level, $2,600 for those at intermediate-year level, and $2,800 for those at terminal-year level, plus exemption from tuition, service fee, and hospital-medical-surgical fee. An allowance of $500 is granted for each dependent. Recipients of these awards may elect a nine months' tenure, rather than twelve months, with a corresponding decrease in the stipends and allowances. In addition, traineeship awards may be available for the summer session only.

Inquiries concerning traineeships should be directed to the appropriate department at the University.

Public Health Service Traineeships. The traineeships support students enrolled for advanced training in health and health-related areas, such as social work, mental health, vocational rehabilitation, speech correction, the life sciences, the agricultural sciences, psychol-

ogy, biochemistry, medical librarianship, sanitary engineering, and sociology.

A traineeship is virtually equivalent to a fellowship since the stipend is considered a tax-free gratuity and no duties are required other than those directly contributing to the training program. The stipends vary from $1,800 to $2,800 or more, depending on the recipient's level of study and area of specialization. Most Public Health Service Traineeships provide tuition and fees and dependency allowances. Inquiries should be directed to the student's major department.

Assistantships

The various departments of the University employ graduate students as teaching or research assistants. The usual appointment is for half-time service, at a salary of $2,700 for the academic year (September to June). Applications may be made directly to the appropriate department.

Assistants holding appointments ranging from 25 through 67 per cent of full-time service are exempt from the tuition and service fee, but not from the hospital-medical-surgical fee. For more detailed information concerning fee assessment, see pages 44 to 54.

Appointments for part-time assistantships also are available in nonteaching bureaus and agencies. For further information and application materials, write directly to: Bureau of Business Management, Bureau of Economic and Business Research, Center for Instructional Research and Curriculum Evaluation, Institute of Communications Research, Institute of Government and Public Affairs, Institute for Research on Exceptional Children, Physical Environment Unit, and Small Homes Council-Building Research Council. All agencies may be addressed in care of the University of Illinois, Urbana 61801.

Part-time appointments as student residence hall counselors are also available. These provide cash stipends plus room and board and the same exemption from tuition and the service fee accorded other staff members. For further information, students should write to the Residence Staff Adviser, 174 Weston Hall, Champaign, Illinois 61820, or to the Associate Dean of Student Personnel, 130 Student Services Building, Champaign, Illinois 61820.

Tuition and Fee Waivers

These awards provide exemption from the tuition and service fee, but not from the hospital-medical-surgical fee, for the academic year

and the summer session immediately preceding or following. Students holding these awards must be in residence and must register for at least three units each semester during the academic year and may accept part-time or incidental employment not to exceed twenty hours a week either within or outside the University.

Veterans who are admissible to a graduate program and who meet certain residence requirements may be eligible for exemption from tuition under the state statute concerning Military Scholarships. Further information may be obtained from the Director of the Undergraduate Scholarship Program, 707 South Sixth Street, Champaign, Illinois 61820.

How to Apply

Application materials with instructions may be obtained from the Graduate College or from any graduate department. Only one application form is needed to apply for any of the types of financial aid listed on pages 25 to 29. A specially marked application for the National Defense Education Act Title VI Fellowships may be obtained from Professor C. Ernest Dawn, Chairman of the Committee on National Defense Foreign Language Fellowships, 350 Armory, Champaign, Illinois 61820.

To be considered for a University Fellowship beginning in June or September, the application must be filed with the major department no later than February 15, but preferably early in January. (The School of Music deadline is February 1, except that the deadline for applications in the area of voice is January 15.) These deadlines do not apply to applications for assistantships, tuition and fee waivers, and certain industrial and special fellowships. However, applicants for such appointments are strongly urged to submit their applications as early as possible since many departments offer assistantships and other awards at the same time they consider applications for fellowships.

Announcement of Awards

The first list of fellowship awards is announced about March 15. Recipients are expected to accept or decline by April 15. The University adheres to the resolution adopted by the Council of Graduate Schools in the United States which provides that if the recipient of an award indicates his acceptance before April 15, he will have complete freedom through April 15 to resign in order to accept another appointment. After April 15, however, he may not accept another

award without obtaining a formal release from the first commitment.

It is understood that the award of a graduate appointment for one year involves no commitment for continued support by the University for subsequent years.

Loan Funds

Information and application forms concerning loans from the University, the National Defense Education Act, the Illinois Guaranteed Loan Program, the United Student Aid Fund, short-term emergency loans, and other loan funds may be obtained from the Student Loan Office, 707 South Sixth Street, Champaign, Illinois 61820. The amount of the loan which is finally approved is based on the financial need of the applicant as computed from information obtained from the applicant and the availability of funds. Priority is given to students with superior academic backgrounds.

University Loans. A student may apply to borrow from the University Loan Fund an amount not to exceed $1,000 per year or a total of $2,500. Loans are repayable, at a minimum of $30.00 monthly, at an interest rate of 3 per cent annually, beginning four months after leaving the University, with the requirement that all loans be repaid within four years.

National Defense Education Act Loans. Eligible graduate students may request financial assistance from funds provided to the University under Title II of the National Defense Education Act. The limit is $2,500 per year to a total of $10,000. Repayment begins in monthly installments, at an interest rate of 3 per cent annually, nine months after the borrower has ceased to pursue a full-time course of study. The entire loan must be repaid within ten years after repayment begins.

Up to 50 per cent of a National Defense Education Act loan is cancelled if the borrower serves as a full-time teacher in a public or nonprofit private school in the United States. This applies to elementary or secondary schools and institutions of higher education. Such cancellation is at the rate of 10 per cent of the loan, for each academic year, or its equivalent, of such service. Also, if teaching service is performed in an elementary or secondary school officially classified as having a high percentage of students from low income families, cancellation is at the rate of 15 per cent per year with no limit on total cancellations.

Illinois Guaranteed Loan Program. A borrower must be a citizen of the United States and a bonafide resident of the state of Illinois. All

fifty states are participating in the Guaranteed Loan Program. A non-Illinois resident must seek assistance through the program in his home state.

Graduate students may apply to borrow from a minimum of $300 to a maximum of $1,500 during an academic year while enrolled for full-time study.

No loan is granted in an amount which exceeds the established educational expenses at the eligible college selected by the student, minus other financial aid received from or through the University.

Repayment of principal is required at a minimum monthly rate of $30 beginning nine months after the borrower ceases to be a full-time student, and the loan must be paid in full within six years from the date the borrower was last a full-time student.

The maximum interest rate permitted by law is 7 per cent simple interest, which begins on the date of the loan. If the family of the borrower has an annual "adjusted income" (gross income less 10 per cent and deductions for dependents) of less than $15,000, the federal government pays all of the interest while the borrower is in college, and the borrower pays all interest during the period of repayment. A student not qualified for federal interest subsidy is required to pay his own interest on a semi-annual basis from the day the money is first made available to him.

United Student Aid Fund Loans. A graduate student may apply for assistance up to $1,500 per year to a combined total of $7,500 at the time of graduation. (This total includes loans not in excess of $1,000 a year as an undergraduate student.) The amount of a loan is determined on an individual basis. No notes under this plan may bear more than 7 per cent simple interest. Repayments begin the first day of the fifth month after the holder ceases to be a full-time student. The normal repayment period is thirty-six months, but larger loans may be repaid over periods ranging up to fifty-four months. Monthly installments may not be less than $30.

Short-Term Emergency Loans. Short-term emergency loans up to a maximum of $100 may be requested by students. The loan must be paid within sixty days, or by the end of the semester, whichever date is earlier. Request forms may be obtained from the Student Loan Office.

Other Loan Funds. The Student Loan Office maintains a list of additional loan sources, such as private foundations, church-related sources, and bank sources. This information will be provided upon request to a student needing financial assistance.

ACADEMIC AND OTHER REGULATIONS

A student should familiarize himself with the academic requirements and regulations of the Graduate College and of his major department. He is responsible for complying with these regulations and for fulfilling all requirements for his particular degree. Every graduate student should have a Graduate College catalog and, if available, a department brochure. The Graduate College calendar included in this catalog is also printed separately and may be obtained from the Graduate College, 330 Administration Building.

Petitions

The normal procedures and requirements of the Graduate College are indicated in this catalog. A student may petition to the Dean of the Graduate College for exceptions, but he should do so only after consultation with his adviser. Forms for such petitions may be secured in the departmental offices and at the Graduate College.

Residence

Each degree candidate must spend a certain period of time in "residence." Residence is realized when a student lives in the community, or its immediate surroundings, and devotes an appreciable portion of his time to graduate studies. A student who is regularly employed outside the Urbana-Champaign community is not considered to be in residence even though he is registered in a campus course.

Work Completed Elsewhere

A candidate for the doctorate, who has received a master's degree from a recognized institution, receives the equivalent of eight units of credit for that work. If such credit is to be used in partial fulfillment of the requirements for the doctorate, he is examined on the content of the courses involved at the time of the preliminary examination.

A student who has completed graduate work in a recognized institution, but has not taken a degree, may petition to obtain credit toward an advanced degree by passing examinations in this work. Admission to such examinations requires the approval of the departments concerned and of the Dean of the Graduate College. The acceptance of credit for work completed elsewhere does not reduce the residence requirement for an advanced degree.

Time Limit for Advanced Degrees

A candidate for the master's degree must complete all requirements for the degree within five calendar years after his first registration in the Graduate College.

A candidate for the doctor's degree must complete all requirements for this degree within seven calendar years after his first registration in the Graduate College, except as noted in the following paragraph.

A candidate for the doctorate who has received a master's degree elsewhere must complete all requirements for the degree within five years after his first registration in the Graduate College. A student whose program of study is significantly interrupted after he receives a master's degree from the University of Illinois and who later returns to work for his doctorate will have five years from the date he returns to complete degree requirements.

Advisers

Every graduate student must have an adviser in the department or division in which he is a degree candidate. The adviser's primary duty is to assist in planning a program of graduate study that fits the needs of the student and satisfies departmental and Graduate College requirements. A new student should go to his major department to discuss the selection of an adviser.

Unit Credit for Courses

Graduate credit is measured in terms of units. One unit is considered the equivalent of four semester hours. The normal program for a full-time graduate student is four units each semester or two units for an eight-week summer term. With his adviser's approval, the student may take a maximum of five units in a semester, or two and one-half units in a summer term.

Grading System

Final grades for didactic courses are recorded as follows: A, B, C, D (lowest passing grade), and E (failure), with numerical computations of grade-point averages based on a system where A = 5.0. Other symbols in use, but not included in the computation of a grade-point average are:

W—Officially withdrawn from a course.

Ex—Temporarily excused. Used by the instructor if he has granted an extension of time to a student who has not completed the final examination or other requirements for the course. An excused grade must be replaced by a letter grade no later than the end of the next semester in which the student is registered or one year from the date the excused grade was incurred if the student does not register. Failure to complete the work within these time periods results in a grade of E.

Df—Grade temporarily deferred. Used only in research (the courses numbered 499) and other approved courses that extend beyond one semester.

S or U—Satisfactory or Unsatisfactory. Used only as final grades for the thesis research course (499) and in certain approved noncredit courses.

P or F—Pass or Fail. Used only if a graduate student has registered for a course under the pass-fail option with the approval of his major department. See below.

Pass-Fail Option

Subject to the restrictions imposed by the major department, a graduate student with the approval of his adviser may register for graduate credit under this option with the understanding that there must be at least two units of course work on the Urbana-Champaign campus with grades of A through D for every unit taken on a pass-fail basis. Students may elect this option only during advance enrollment, during regular registration days, or within the first two weeks of the term. Requests to take a course on this basis, or to retain the course and drop the option, at other times will not be granted.

Scholastic Requirements

The minimum grade-point average required by the Graduate College for an advanced degree is 3.75 (A = 5.0); the minimum average required by a department may be higher than 3.75. The grade-point average (GPA) is computed at the end of every term and is shown on the Semester Report that is mailed to each student as soon as possible after the final day of examinations. The GPA computation includes only units with grades of A through E. It excludes grades of Pass, Fail, Ex, Df, S, U, and credit for work completed elsewhere. A student who receives a grade of E should consult with his adviser to determine whether he should repeat the course and whether or not the credit he

earns in that course, if repeated with a passing grade, may be applied to an advanced degree.

A student who has completed four or more units with an average of less than 3.75 receives a warning letter from the Graduate College. If the average has not been raised to 3.75 upon the completion of four additional units, or if the average falls below 3.75 thereafter, the student is disqualified as a degree candidate. Attainments other than satisfactory grades, however, are taken into consideration by the adviser and the major department in determining qualifications for an advanced degree.

Maximum and Minimum Registration

Students holding University Fellowships or other fellowships awarded by the University must carry a full program (four units or the equivalent). Those awarded tuition and fee waivers must carry a minimum program of three units or the equivalent. The academic work carried by assistants and others on the University staff is limited by statute, and those employed outside the University are expected to reduce their programs of study in accordance with these regulations. The maximum amount of academic work is determined by the terms of employment as follows:

	Maximum Registration	
Terms of Employment	*Semester*	*Summer Session*
Full time	1 unit	1 unit
Three-fourths time	2 units	1¼ units
Two-thirds time	2¼ units	1½ units
One-half time	3 units	1¾ units
One-third time	3¾ units	2 units
One-fourth time	4 units	2 units

Exceptions to the *semester* schedule are possible by means of a special petition procedure. This privilege does not apply to summer session.

Military Deferment

The Selective Service System through the local board determines the student's deferment status. Generally, the following criterion is used as a guide for deferment:

Verification from the Graduate College that the student is satisfactorily pursuing a full-time program of study. A full-time program involves (a) three or more units of graduate study, (b) a program of

both graduate and undergraduate courses equivalent to twelve or more semester hours, (c) two and one-half units plus an appointment for not less than one-third time, or (d) two units of graduate study and an appointment as a teaching or research assistant for not less than one-half time.

It is the student's responsibility to initiate the appropriate request or form that will enable the University to send accurate information to his local board. A student who has been issued a permit to enter the Graduate College but who has not had an opportunity to register, may request the Selective Service clerk in the Office of Admissions and Records, 69 Administration Building, to notify his local board of his acceptance.

A student who is registered should obtain a Status Form for Graduate Students Seeking Deferment from his major department or the Graduate College. This form must be completed by the student, certified by the executive officer of the major department, and filed with the Office of Admissions and Records, 69 Administration Building, at the times shown below:

(1) When the student first registers and every September thereafter.
(2) When a "change of program" is initiated which will reduce the student's program to less than three units or the equivalent (twelve semester hours).
(3) When the student's degree objective or anticipated degree date changes.

The University may inform and justify, but has no control over decisions made by the Selective Service System. A student who is reclassified by his board and who wishes to appeal the reclassification should notify his local board in writing that he wishes to appeal. The right to appeal is forfeited thirty days after the reclassification date.

Conferring of Degrees

Advanced degrees are conferred in February, June, August, and October, except that the doctorate is not awarded in August. No more than two graduate degrees will be conferred for work completed at the University of Illinois.

THE MASTER'S DEGREE

Master's degrees are offered in the fields indicated on pages 8 and 9. Unless otherwise specified in the departmental listings, the credit requirement for this degree is at least eight units. Three of the eight

units must be in courses numbered in the 400 series, and two of these three must be in the major field.

Residence

A candidate must spend at least two semesters, or the equivalent, in residence and must earn at least half the required units while in residence. See page 32.

Major Requirement

At least four units of work must be in the area of concentration. The remaining credit may be in that field or in other courses appropriate to the student's educational goals.

Thesis

A student electing or required to write a master's thesis should file the subject of the thesis at the Graduate College, 321 Administration Building, at least six weeks prior to graduation. No more than three units of thesis credit may be included in an eight-unit program. Credit in thesis research can not be applied to a degree unless a thesis is submitted.

For specific instructions regarding the format of the thesis, the student should obtain a copy of the leaflet, *Instructions for Preparation of Theses,* from the Graduate College Thesis Office, 306 Administration Building.

Master's Degrees in Teacher Education

Programs leading to master's degrees for teachers are available in the areas listed below and in a number of the departments of the College of Education (see page 164).

Agricultural Education—page 69
Art—page 91
Biological Sciences and General Science—page 267
Chemistry—page 118
Earth Science—page 223
English—page 197
English as a Second Language—page 198
French—page 214
Geography—page 218
German—page 227
Health Education—page 231
Home Economics—page 241
Latin—page 140
Mathematics—page 298
Music—page 321
Physical Education—page 340
Physical Sciences—page 342
Physics—page 343

Russian—page 376
Social Studies—page 380
Spanish—page 393
Speech—page 398
Speech Correction—page 398

Applicants who have not completed requirements of a four-year undergraduate curriculum leading to teacher certification may be admitted to these programs on the approval of the appropriate adviser and the Coordinator of Teacher Education, but they must complete teacher certification requirements, as well as the usual program requirements, in order to qualify for the master's degree in teacher education.

Requirements for Teacher Certification

The requirements for teacher certification, referred to above, are of three kinds. The student must meet general education requirements and teaching field requirements equivalent to those of the appropriate undergraduate curriculum. The determination of this equivalence is ordinarily made by the adviser. The student must also meet the professional education requirements equivalent to those of the undergraduate curriculum. If the student has not fulfilled this requirement (eighteen hours of credit in professional education courses), he may take the courses listed below to satisfy this requirement.

Educational Psychology 211 (or equivalent) .....3 semester hours
Elementary Education 231 or Secondary Education 241 ...3-5 semester hours
Educational Practice 232 or 242 .....5 semester hours
History and Philosophy of Education 304 .....½ unit
History and Philosophy of Education 305 .....½ unit
Educational Psychology 311 .....½ unit
Educational Psychology 312 .....½ unit

If the credit in the above list is given in terms of units, it may be assumed that such credit will apply toward requirements for the master's degree as well as the requirements for certification. Educational Psychology 211 is prerequisite to Educational Psychology 311 and 312, and may be waived on the basis of a non-credit proficiency examination administered by the Department of Educational Psychology. A successful proficiency examination, however, does not serve to reduce the eighteen hours of professional education courses required for certification.

Educational Practice 220, 232, 238, or 242, whichever is appropriate, is required of all students seeking teacher certification. Educational practice (student teaching) is administered under the Illinois Teaching Experience Laboratory. Information concerning student teaching in various fields may be obtained at the following locations in the Edu-

cation Building: Secondary Education, Room 398; Elementary Education, Room 304; Special Education, Room 210; and Vocational and Technical Education, Room 347.

Students requesting educational practice for teacher certification should request application forms through one of the offices listed above. It is essential that this be done immediately on receiving notice of admission to the Graduate College. Only students admitted to fifth-year teacher education programs as listed on page 37 may apply for student teaching assignment.

To be considered for admission to student teaching, graduate students must have completed one semester of work on the Urbana-Champaign campus and be registered in a teacher education program. Registration in student teaching requires concurrent registration in the appropriate section of the specialized course in technics of teaching.

Students pursuing both certification and master's degree requirements should anticipate at least the equivalent of three semesters of full-time study.

THE DEGREE OF DOCTOR OF PHILOSOPHY

The degree of Doctor of Philosophy is offered in the fields indicated on pages 8 and 9. General requirements are described below; special requirements are given in departmental listings. For information about doctoral level professional degrees in business administration, education, law, music, and psychology, see the appropriate sections.

Residence

A doctoral program includes three stages. At least two of these stages must be completed in residence; the residence period must include two successive semesters in the second or third stage.

The *first stage* ends when the candidate receives a master's degree or earns the equivalent credit (eight units or thirty-two semester hours); the *second stage* comprises eight units of work, fulfillment of departmental requirements, and a successful preliminary examination; the *third stage* comprises research and seminars (eight units), preparation of the dissertation, and the final examination. For maximum time allowed, see page 33.

Programs of Study and Areas of Specialization

A student's courses and research are planned with his adviser. Consideration is given to previous academic training, career objective, the

general requirements of the Graduate College and the major department. The student should become familiar with these requirements and satisfy them as soon as possible.

The major area of specialization is a selection of courses which are closely related but not all necessarily offered by the major department.

If a student elects or is required to declare a minor outside his major department, the selection must be approved by the department or division concerned. A minor area of specialization is a group of courses that are related but may be offered by more than one department.

Language Requirements

Each department determines its own foreign language requirements, if any. The Graduate College, however, officially records language proficiency only if the student passes a 401 language reading course with an A or B, receives a satisfactory score on the Educational Testing Service test, or is certified as proficient by a member of the faculty in the language department.

Preliminary Examination

To enter the third stage of a doctoral program (see page 39), a candidate must pass a preliminary examination to test his qualifications for further advanced study and research. The examination may be written, oral, or both, according to departmental requirements. The candidate is certified for admission to the third stage by a committee appointed by the Dean of the Graduate College on the recommendation of the executive officer of the major department. To maintain his status as a degree candidate, a student who has passed the preliminary examination must register each semester until the degree is conferred (see third stage requirements, page 39).

If a student does not complete his degree requirements within five years after passing his preliminary examination, a second preliminary examination is required.

Thesis

The Doctor of Philosophy is primarily a research degree and the candidate must demonstrate his capacity for independent research by the production of an original thesis on a topic within his major field of study. The subject of the thesis must be reported to the doctoral committee and to the Graduate College at the time of the preliminary examination.

Candidates engaged in thesis research may find it desirable or expedient to publish, prior to the conferral of the degree, certain findings that later will be incorporated in the dissertation. In this case appropriate acknowledgment of the earlier publication should be included in the dissertation. The Graduate College encourages such publication, but the thesis in its entirety may not be published before all degree requirements have been completed.

Directions regarding the format of the thesis are given in the leaflet, *Instructions for Preparation of Theses,* which may be obtained in the Graduate College Thesis Office. The candidate must submit to the Graduate College, no later than the date specified in the current calendar, (1) the original and the first carbon copy (or two copies reproduced by an approved method) of his thesis, and (2) one typewritten copy of an abstract not exceeding six hundred words.

Each candidate who passes the final examination must pay a $25.00 microfilm fee. This provides for (1) microfilming the complete thesis, with one copy deposited in the University of Illinois Library, and (2) publication of the abstract in *Dissertation Abstracts.*

Final Examination

The candidate is admitted to the final examination by the Dean of the Graduate College upon completion of the dissertation and the recommendation of the major department.

OTHER EDUCATIONAL OPPORTUNITIES

Traveling Scholar Program

The University of Illinois is one of eleven midwestern member universities of the Committee on Institutional Cooperation and a participant in the Committee's Traveling Scholar Program. This program enables an advanced graduate student to work at another campus for a semester in order to take advantage of special course offerings or research facilities, such as a unique laboratory or library collection, not available at his own institution. A CIC Traveling Scholar registers at his home university, and credit for the work is recorded there. Appointment as a Traveling Scholar is based upon the individual submission to the Graduate College of an application which carries the strong endorsement of the student's major department and the approval of the host institution. Each university retains the right to accept or reject any student desiring to study under its auspices. A student inter-

ested in participating in the program should consult with the head of his major department.

Military Science (Reserve Officers' Training Corps)

Army R.O.T.C. is offered at the University of Illinois as outlined in the Undergraduate Study catalog.

A student in a graduate or professional course who completed the basic course as an undergraduate or who received appropriate credit may be enrolled in the advanced course any time prior to the beginning of the last two years of his graduate program, providing he meets the eligibility requirements listed in the Undergraduate Study catalog.

A special two-year advanced program is offered for students who have two academic years remaining at the University, but who did not take the basic course through on-campus instruction. Under this program, the basic course is accomplished by completion of a summer training camp of not less than six weeks' duration at an active army installation. While attending this camp, students are paid at the same rate as a basic trainee; and they are allowed travel expenses to and from camp.

Further information may be obtained from the Professor of Military Science, 113 Armory, University of Illinois, Champaign, Illinois 61820.

Auditing Privileges

A graduate student or a person not registered in the University of Illinois is permitted to attend classes (other than laboratory courses) as an auditor, provided a Visitor's Permit bearing the approval of the instructor and the Dean of the Graduate College is filed with the Records Office, 69 Administration Building. A student should not enter on his program card any courses which he plans to attend as an auditor. Visitor's Permits are available from the Graduate College, 330 Administration Building.

Extramural Courses

Graduate courses in a few areas of study are offered at various centers throughout the state. A student who is employed full time may not register for more than one unit of extramural course work in any one semester nor more than one unit in any combination of extramural and campus courses.

Because extramural course work is not considered work in residence, credit earned in such courses can be applied toward an advanced degree only if (1) the courses are approved in advance by the adviser and constitute part of a well integrated program, and if (2) the total extramural credit does not exceed two units (the Ed.M. and the Advanced Certificate excepted). Credit earned in extramural courses can not be applied toward the second stage of a doctoral program (see page 39).

Correspondence Courses

Credit earned in correspondence courses can not be applied toward an advanced degree. However, it is possible to fulfill certain prerequisites or remove deficiencies through correspondence work. A catalog of correspondence courses offered by the University of Illinois may be obtained from the Division of University Extension, Correspondence Courses, 104 Illini Hall.

HOUSING

The University has residence facilities in Arthur Hill Daniels Hall and Stuart Pratt Sherman Hall, two separate residence hall complexes for approximately 1,000 single graduate students, both men and women. Semester contract food service in undergraduate dining halls can also be arranged. In addition, the University provides a limited number of apartments for married students, with priority in assignment given to part-time research and teaching assistants.

The University is committed to a policy of nondiscrimination in housing with respect to race, religion, and national origin. All University-owned housing, as well as privately owned housing which is University approved, must be operated in compliance with this policy.

Applications for accommodations in the University graduate residence halls or the University-owned apartments for married students may be obtained from the Housing Division, 420 Student Services Building, Champaign, Illinois 61820. The Housing Division also maintains a courtesy list of private apartments and rooms available in homes in the community. Office hours are from 8:00 A.M. to 5:00 P.M. Monday through Friday, and from 9:00 A.M. to 12:00 noon each Saturday. During the weekend immediately prior to registration, in September and February, office hours also are maintained from 1:00 to 4:00 P.M. Saturday and 10:00 A.M. to 4:00 P.M. Sunday. University offices are not open on national holidays.

FEES AND EXPENSES

Expenses

Graduate residence halls, operated by the University, offer single rooms at rates ranging from $472 to $568 for the academic year and double rooms from $408 to $536 per person for the same period. A board contract may be purchased for one semester for approximately $274.

Monthly rentals for University-owned apartments for married students range from $80 for a one-room efficiency to $108 for larger units, plus utilities.

Single rooms in private residences in the community range from $40 to $55 a month and double rooms from $35 to $50 per person. Privately-owned apartments also are available at rates ranging from about $85 to $175 per month.

For further information concerning housing, see page 48.

Tuition and Fees, 1969–1970

(Subject to change.)

Tuition and other fees, as indicated below, are payable in full when the student registers, unless the installment plan of payment is elected. An additional charge of $2.00 is made for this privilege.

SEMESTER

	Full Program		*Partial Programs*			
	Range I		Range II		Range III	
	Above 10 hours Above 2½ units		Above 5 to 10 hours Above 1¼ to 2½ units		Above 0 to 5 hours Above 0 to 1¼ units	
	Resident	Non-resident	Resident	Non-resident	Resident	Non-resident
Tuition (except those holding exemptions)	$123.00	$426.00	$ 87.00	$300.00	$51.00	$171.00
Service Fee[1]	40.00	40.00	25.00	25.00	10.00	10.00
Hospital-Medical-Surgical Fee[2]	16.00	16.00	16.00	16.00	16.00	16.00
Total	$179.00	$482.00	$128.00	$341.00	$77.00	$197.00

* Students registered in *either one* of the five and one-half week summer law sessions pay one-half of the tuition and service fee established for the twelve-week term, rounded to the next higher even dollar. They are also subject to the same hospital-medical-surgical fee applying to registrants in the eight-week summer session.

TWELVE-WEEK SUMMER TERM (SOCIAL WORK AND INSTITUTES) AND ELEVEN-WEEK SUMMER LAW PROGRAM*

	Full Program		*Partial Programs*			
	Range I		Range II		Range III	
	Above 8 hours Above 2 units		Above 4 to 8 hours Above 1 to 2 units		Above 0 to 4 hours Above 0 to 1 unit	
	Resident	Non-resident	Resident	Non-resident	Resident	Non-resident
Tuition (except those holding exemptions)	$ 82.00	$284.00	$58.00	$200.00	$34.00	$114.00
Service Fee[1]	30.00	30.00	20.00	20.00	10.00	10.00
Hospital-Medical-Surgical Fee[2]	16.00	16.00	16.00	16.00	16.00	16.00
Total	$128.00	$330.00	$94.00	$236.00	$60.00	$140.00

EIGHT-WEEK SUMMER SESSION

	Full Program		*Partial Programs*			
	Range I		Range II		Range III	
	Above 5 hours Above 1¼ units		Above 2½ to 5 hours Above ¾ to 1¼ units		Above 0 to 2½ hours Above 0 to ¾ unit	
	Resident	Non-resident	Resident	Non-resident	Resident	Non-resident
Tuition (except those holding exemptions)	$62.00	$213.00	$44.00	$150.00	$26.00	$ 86.00
Service Fee[1]	20.00	20.00	15.00	15.00	5.00	5.00
Hospital-Medical-Surgical Fee[2,3]	16.00	16.00	16.00	16.00	16.00	16.00
Total	$98.00	$249.00	$75.00	$181.00	$47.00	$107.00

[1] Persons on appointment for at least 25 per cent of full time on the academic, administrative, or permanent nonacademic staff of the University, or on the staffs of allied agencies, and persons registering *in absentia* or in courses conducted off-campus are exempt from the service fee.

[2] Students presenting evidence of equivalent coverage may receive a waiver of the hospital-medical-surgical fee upon approval of a petition submitted to the University Insurance Office not later than the final day established for full refund of fees. A signed waiver and assumption of responsibility is required. Persons registered for thesis research *in absentia* are not assessed this fee.

[3] If insurance coverage for the period between the close of the summer session and the beginning of the first semester is not desired, one-half of the assessed fee ($8.00) will be refunded if requested in writing prior to the final date established for full refund of fees.

NONCREDIT COURSES

Students (except those holding exemptions) who register in noncredit courses pay tuition and fees as follows:

(1) Persons who register *on campus* for doctoral thesis research (499) only, without credit, are charged the following:

SEMESTER

Tuition $10.00
Service Fee 10.00
Hospital-Medical-Surgical Fee 16.00

EIGHT-WEEK SUMMER SESSION

Tuition $10.00
Service Fee 5.00
Hospital-Medical-Surgical Fee 16.00

(2) Persons who register for doctoral thesis research (499) *in absentia* without credit are charged only a tuition fee of $10.00
(Those registered *in absentia* for credit pay the regular tuition, resident or nonresident, as applicable.)

(3) Persons who register in noncredit seminars, either alone or in addition to other courses ..... *No charge*
(Regular tuition and fees which are applicable are assessed for other courses taken concurrently.)

(4) Persons who register in noncredit courses in addition to credit courses pay ..... *No additional charge*
(If taken alone, registrations in noncredit courses other than thesis research and seminars are assigned to Range III.)

(5) University employees who register at the request of their department in noncredit courses especially established to improve the work of the employee ..... *No charge*
(Regular tuition and fees which are applicable are assessed for other courses taken concurrently.)

(6) Persons wishing to attend a campus course as a visitor only (special permit required) pay for each course a fee of $15.00

Residence Classification

The residence classification of an applicant is determined on the basis of information given on his application and other credentials. Tuition is assessed in accordance with this decision. Errors in residence classification or in assessments discovered following registration may result in adjustments of charges. If the student believes he has a legitimate cause for change of status from nonresident, he shall pay the nonresident tuition but may, by petition, on a form provided by the Office of Admissions and Records, request a change. Petitions are considered *within thirty days* from the date designated in the official University Calendar as that upon which instruction begins for the academic pe-

riod for which the charge is payable. However, if the nonresident tuition was not assessed on or prior to that date, the claim for refund may be filed *within thirty days* after the nonresident tuition was assessed and the student was given notice of its assessment. Tuition and fees will not be adjusted for that academic term because of change in residence classification if the petition is not filed within these time limits. Additional evidence to substantiate a request may be required. If the student expects to ask for a change of residence classification, it is advisable for him to request the adjustment be made prior to the registration period.

In the event a student who claims he is a resident student is dissatisfied with an adverse ruling of the Director of Admissions and Records, he may obtain a review of such decision by the Legal Counsel of the University by filing a written request with the Director of Admissions and Records within twenty days after he has been notified of the ruling. In such cases, the decision of the Legal Counsel is final.

Further information concerning residency may be secured by contacting the Office of Admissions and Records, 100a Administration Building, Urbana, Illinois 61801. A brochure entitled *Regulations Governing Assessment of Resident or Nonresident Student Fees* is also available.

Special Fees

Below is a partial list of special fees pertaining to graduate students. A complete schedule of tuition and fees may be obtained from the Office of Admissions and Records, 132 Administration Building.

Application Fee. Beginning in September, 1970, each applicant for admission or readmission to the University must submit with his application a nonrefundable fee of $15.00. This fee is not applicable on tuition and other fees.

Advance Deposit on Tuition and Fees. Each new and readmitted student to the Graduate College (except foreign students who, at the time of application, are residing outside the United States, and certain others specifically exempted) who wishes to register for a fall or spring semester on the Urbana-Champaign campus is required to make an advance deposit of $30.00 in order to secure the place reserved for him.

This is not an additional cost for attending the University but is applied to each student's tuition and fees in the semester for which he is approved. In case the student fails to enter the University in that semester, the deposit may not be applied toward any future registration.

The deposit should not be sent until requested by the University. It is nonrefundable except in very special cases.

The following graduate students may confirm their intentions to register without payment of the advance deposit:

(1) Foreign students residing outside the United States at the time of application.

(2) New and readmitted graduate students holding a fellowship, academic or nonacademic staff appointment, or graduate tuition and fee waiver.

(3) New and readmitted graduate students who receive a financial award from an agency outside the University, and whose complete tuition and service fee are billed to the agency by the Bursar.

(4) Doctoral candidates who have passed the preliminary examination.

Late Registration Fine—$15.00. All students, whether on appointment or not, who complete registration for courses on campus after the close of the regular registration, are subject to this fine in addition to the tuition and fees. A student's registration is not complete until his tuition and fees have been paid in full, or he has made arrangements with the Bursar's Office for deferment of payment. Students who register late in any term pay the same tuition and fees as students who register at the beginning of the term.

Change of Program Fee—$1.00. This fee is charged for every course change slip issued at the request of the student after the completion of registration.

Visitor's Fee (Campus Courses). Persons not otherwise registered in University courses and students registered on campus on a partial program fee schedule (Range II or III) are charged a fee of $15.00 for each course attended as a visitor only.

Assessments and Exemptions

Assessments. For tuition and fee assessment purposes, a staff appointment must be an established position for a specific amount of time and a salary commensurate with the percentage of time; it must require service for not less than three-fourths of the term. This is interpreted as a minimum of three and one-half months in a semester, nine weeks in a quarter, and six weeks in an eight-week summer session. Staff tuition and fee privileges do not apply to students employed on an hourly basis in either an academic or nonacademic capacity, or to persons on leave without pay.

For fee assessment purposes, a *permanent* nonacademic employee is defined as a person who has been assigned to an established, permanent, and continuous nonacademic position and who is employed for at least 25 per cent of full time.

University employees appointed to established Civil Service positions whose rate of pay is determined by negotiation, prevailing rates, union affiliation, etc., are not considered as paid on an hourly basis and are entitled to the same tuition and fee privileges accorded to other staff members under the regulations.

Any student who resigns his staff appointment, or whose appointment is cancelled before rendering service for at least three-fourths of the term, becomes subject to the full amount of the appropriate tuition and fees for that term unless he withdraws from his University classes at the same time the appointment becomes void. Such students are not assessed tuition and fees for that term if they file clearance for graduation within one week after the appointment becomes void.

For those who qualify under items 1 through 4 below, who are eligible for such waiver in the final term of the academic year, except as indicated under summer session on page 51, this privilege is also extended to the summer session immediately following.

Exemptions. A student may be exempted from one or more of the usual charges if he qualifies under the following conditions:

TUITION IS WAIVED FOR:

(1) Holders of tuition waiver scholarships.
(2) All academic employees of the University or of allied agencies on appointment for at least 25 per cent but not more than 67 per cent of full-time services.
(3) All permanent nonacademic employees of the University or allied agencies on appointment for at least 25 per cent of full time who register in University courses in Range II or III.
(4) Holders of graduate tuition and fee waivers awarded by the Graduate College.
(5) Holders of grants or contracts from outside sponsors which provide payments to cover the total costs of instruction.
(6) Cooperating teachers and administrators who receive assignment of practice teachers. (Exemption is provided in one semester, quarter, or summer session for each semester or quarter of assignment within the same calendar year—September through August.)
(7) Persons registered in noncredit seminars only.

(8) University employees registered at the request of their departments in noncredit courses especially established to improve the work of the employee.
(9) Academic staff members emeriti.

NONRESIDENT PORTION OF TUITION (IF SUBJECT TO PAYMENT OF TUITION) IS WAIVED FOR:

(1) All staff members (academic, administrative, or permanent nonacademic) on appointment for at least 25 per cent of full time with the University or the allied agencies.
(2) The faculties of state-supported institutions of higher education in Illinois.
(3) The teaching staff in the private and public elementary and secondary schools in Illinois.
(4) The spouses and dependent children of all staff members (academic, administrative, or permanent nonacademic) on appointment with the University or the allied agencies, and of those listed in item 2 above. (Dependent children are those who qualify as dependents for federal income tax purposes.)
(5) The spouses and dependent children of fellows and trainees who are employed as teaching assistants to the extent permitted by their fellowship appointment.
(6) Persons actively serving in one of the Armed Forces of the United States who are stationed and present in the state of Illinois in connection with that service.
(7) The spouses and dependent children of those listed in item 6 above, as long as they remain stationed, present, and living in this state.

For those listed in items 1 through 5 above who are eligible for such waiver in the final term of the academic year, this privilege is also extended to the summer session immediately following.

SERVICE FEE IS WAIVED FOR:

(1) All staff members of the University or allied agencies on appointment for at least 25 per cent of full time.
(2) Holders of graduate tuition and fee waivers awarded by the Graduate College.
(3) Students registered *in absentia.*
(4) Students registered in courses taught off campus, or in off-campus Engineering 102 (Work-Study Cooperative Program) only.
(5) Holders of grants or contracts from outside sponsors if this fee is charged to the contract or grant funds.

(6) Cooperating teachers and administrators described under tuition waivers, item 6 on page 49.
(7) Persons registered in noncredit seminars only.
(8) University employees registered at the request of their departments in noncredit courses especially established to improve the work of the employee.
(9) Academic staff members emeriti.

HOSPITAL-MEDICAL-SURGICAL FEE IS WAIVED FOR:

(1) Students presenting evidence of equivalent coverage upon approval of a petition presented to the University Insurance Office not later than the final day established for full refund of fees.
(2) Persons registered for doctoral thesis research *in absentia.*
(3) Holders of grants or contracts from outside sponsors if this fee is charged to the contract or grant funds.
(4) Students for whom this fee has been assumed by the Graduate College.
(5) Persons registered in noncredit seminars only.
(6) University employees registered at the request of their departments in noncredit courses especially established to improve the work of the employee.
(7) Persons registered in off-campus Engineering 102 (Work-Study Cooperative Program) only.

SUMMER SESSION TUITION AND FEES ARE WAIVED FOR:

(1) Students holding academic appointments to the close of the final term of an academic year either as employees or fellows, and for whom tuition and/or fees have been provided through waiver or through cash payment by an outside agency, are entitled to a waiver of the same kinds of tuition and fees for the summer session immediately following, provided they hold no appointments during that summer session.
(2) Students holding summer session appointments as fellows or as employees are subject to such tuition and fees as would be assessed in accordance with the principles expressed above.

Vehicle Registration. All resident students enrolled in the Graduate College who have a motor vehicle in their possession are required to register this vehicle with the Motor Vehicle Division. The nonrefundable annual fee assessed is $5.00, except that graduate students holding fellowships or teaching or research appointments for at least one-half time have the option of securing at no cost a registration permit with reduced parking privileges.

Student motor vehicle registrations are effective from September 1 to September 1 of each year with all interim registrations (including new, transfer, and returning students) being effective until the following September 1. All motor vehicles in possession of students must be registered within one school day of the acquisition of such vehicles.

The Motor Vehicle Division requires the registration of all motorcycles, motor scooters, and motor bicycles. The fee for such registration is $3.00 per year.

Out-of-state motorcycle operators may operate a motorcycle in Illinois for a period of not more than ninety days in any calendar year if they are licensed to operate a motorcycle in their home state.

Regulations governing use of motorcycles have been revised. Students should contact the Motor Vehicle Division before operating a motorcycle in the University community.

Bicycles also must be registered with this Division every year. No fee is charged for such registration.

Operators of motor vehicles and bicycles must obey all University regulations, and state and municipal motor vehicle traffic laws and ordinances. This includes traffic lights, one-way streets, and other posted traffic signs.

Questions relating to vehicle regulations should be referred to the Motor Vehicle Division, 101 North Mathews Avenue, Urbana, Illinois 61801.

Installment Plan for Payment of University Fees and Housing Charges

Students registered on the Urbana-Champaign campus are given the option of paying tuition, fees, and residence hall charges (in the case of single graduate student housing only) on an installment basis. Tuition and fee charges for each of the first and second semesters are collected in four installments, the first payable at registration and the remaining in each of the following months. The advance deposit, if paid, is applied against the first installment. If this results in overpayment, the remainder is applied against subsequent installments. Summer session charges are payable one-half at registration and one-half during the following month. This plan does not apply to registration in extramural and correspondence courses. University housing for married students is contracted on an annual lease basis and payments are made by the month.

Students electing the installment plan for payment of tuition and fees are assessed a $2.00 service charge. An additional service charge of $2.00 is assessed in the case of the flight instruction fee of $475.00 if paid on the installment basis. There is no service charge for the payment of University housing accounts on the installment basis. Arrange-

ments for payment on the installment plan are made with the Business Office during registration. An installment is considered delinquent on the first day of the month following the date payment is due. Penalties may be imposed on students who permit their accounts to become delinquent, including cancellation of registration.

Refund of Fees

A student subject to tuition and/or fees who files clearance papers for withdrawal from the University during any semester, term, or summer session, for reasons other than military or other approved national defense service, receives a refund as listed below. (Special refund regulations govern withdrawals for active military or other approved national defense service.)

IN A SEMESTER, TWELVE-WEEK TERM, OR ELEVEN-WEEK LAW PROGRAM:

(1) During the first ten days of instruction in a semester or term, refund is made of the full amount of the tuition and fees assessed except for a nonrefundable charge of $36.00.[1] When the total assessment has been less than $36.00, the full amount of the assessment, if any, is nonrefundable.

(2) After the first ten days but within the first half of the semester or term, refund is made of one-half of the total amount of the assessed tuition and fees which remains after deduction of the nonrefundable $36.00.

(3) After the midpoint of the semester or term, no refund is allowed.

IN AN EIGHT-WEEK SUMMER SESSION OR A FIVE AND ONE-HALF WEEK SUMMER LAW PROGRAM:

(1) During the first five days of instruction in the summer session, refund is made of the full amount of the tuition and fees assessed except for a nonrefundable charge of $26.00.[1] When the total assessment has been less than this amount, the full amount of the assessment, if any, is nonrefundable.

(2) After the first five days but within the first half of the summer session, one-half of the amount assessed which remains after deduction of the above mentioned $26.00 is refunded.

(3) After the midpoint of the semester or term, no refund is allowed.

A student who reduces his registration to a lower range receives a re-

[1] The nonrefundable charge includes the hospital-medical-surgical fee, if originally paid; the student who withdraws from the University continues to be covered by the insurance until the close of the term.

fund of the full amount of the difference in tuition and fees specified for such schedules provided the changes are made during the period designated for refund of full fees in case of withdrawal from the University. One-half of the above differences is refunded if the changes are made during the period for one-half refund in case of withdrawal from the University. Thereafter, no rebate is allowed.

Fields of Instruction

Courses open to graduate students are of three types. Those numbered from 300 to 399 are open to advanced undergraduate and graduate students. Those numbered 400 and above are open to graduate students only. Those numbered 500 to 599 are open only to graduate students in certain professional programs.

All courses for graduate students require previous preparation. By consulting this catalog, or, in some cases with the instructor, a student may determine whether he has had the necessary prerequisites for a particular course.

Courses in this catalog are listed alphabetically by departments. The offerings in each field are arranged numerically in groups, with headings to indicate the students for whom they are designed. The 400 series are listed first; courses in the 300 series follow. After the title of each course is a brief description of its contents, the credit given, and the requirements for admission to the course.

A number of courses offer variable credit. At the 300 level, additional work in the nature of special reports, papers, or projects is required of a student who registers for the maximum credit shown. In each case, the student, with the help of his adviser, determines whether or not his schedule allows sufficient time to complete the work required for maximum credit.

At the 400 level, research, reading, and independent study courses provide variable credit; proportionate time devoted to a particular activity can thus be indicated on the student's record.

Unless otherwise specified, it can be assumed that a course is offered at least once during each calendar year. Courses offered only in the summer session are indicated by "S"; courses given in alternate years are indicated with the year of offering. A complete listing of courses for each term is contained in the Time Table, published about six weeks prior to the beginning of each term and available from the Graduate College, 330 Administration Building.

ACCOUNTANCY

The Department of Accountancy offers graduate work leading to the degrees of Master of Accounting Science and Doctor of Philosophy. For graduates of business schools with credit in appropriate undergraduate courses, the M.A.S. degree requirements can be completed in one year. For non-business graduates, the M.A.S. can be earned in two years. The Ph.D. degree takes approximately two years of full-time study and research beyond the M.A.S.

The grade-point average required for admission to graduate study in accountancy is 4.0. Applications from students with a grade-point average between 3.75 and 4.0 are considered on an individual basis. All applicants, native or foreign, are required to take the Admission Test for Graduate Study in Business. This test should be taken early enough to insure that the results will be available to the department prior to action on admission.

Master of Accounting Science. All M.A.S. candidates take Accountancy 462, 481, and 594 and a graduate-level course in both economic theory and organization theory. No thesis is required, although the student may elect to write one. Courses in linear algebra, operations research, and computer programming and applications must be taken, if such courses were not taken in prior academic work.

A candidate with undergraduate background in accounting is required to complete at least eight units of work, four of which must be in accountancy, for the M.A.S. degree. Such a student should have completed an equivalent of the undergraduate curriculum at the University of Illinois at Urbana-Champaign, including twenty hours of undergraduate work in accounting, introductory courses in economic theory and the functional fields of business, two courses in statistics, and courses in finite mathematics and calculus. He may take graduate-level courses for credit to satisfy these requirements.

A student with little or no business and accounting background is required to complete sixteen units of work for the M.A.S. degree. Such a student takes Accountancy 501, 502, 503, and 504 during his first year. Depending upon his background, he also enrolls in courses in statistics, business economics, operations research, business organization, calculus and decision theory. A student who believes he already meets some of the requirements of the two-year M.A.S. program is given the opportunity to substitute elective courses for areas in which he can satisfactorily demonstrate his proficiency. In his second year, he follows the requirements for all M.A.S. students, as described above.

Adequate provisions have been made for electives suited to the particular interests of both one-year and two-year M.A.S. students.

Doctor of Philosophy. A candidate for the Doctor of Philosophy degree must have his admission approved by the departmental admissions committee which may require an oral or written examination.

The requirements for the Doctor of Philosophy degree include a master's degree; course work equivalent to that required for the M.A.S. degree; credit in micro- and macro-economics; a minor or minors of at least four units other than accountancy; at least eight units of accountancy, including Accountancy 483, or equivalent (not less than six of these eight units must be taken for graduate credit at the University of Illinois at Urbana-Champaign); and additional units to bring the total to at least twenty-four, including the eight units allowed for a master's degree. Eight of the twenty-four must be doctoral dissertation units. The student's doctoral program is determined in consultation with his faculty adviser. The student's tentative plans for the doctoral dissertation serve as a guidepost in planning the program.

In addition to the major and minor requirements above, the candidate must

satisfy a non-business field requirement and must pass an oral and written preliminary examination and an oral final examination on his doctoral dissertation. In his preliminary examinations, the candidate must demonstrate a thorough knowledge of accounting theory and of the areas of accountancy in which he specialized, a general acquaintance with the subject matter and bibliography of other areas of accountancy, and proficiency in his minor fields and in the required areas of economic theory, quantitative methods, and organization theory.

More information concerning these programs can be found in the departmental publication, *Graduate Programs in Accountancy*. Requests for this publication and for other information should be addressed to the Head of the Department of Accountancy, 360 Commerce and Business Administration Building (West), Urbana, Illinois 61801.

GRADUATE FACULTY

Professors: E. J. DeMaris (Head of Department), N. M. Bedford, R. I. Dickey, C. F. Dunham, P. E. Fess, H. P. Holzer, Dorothy Litherland, G. E. Lukas, R. K. Mautz, C. A. Moyer, K. W. Perry, H. M. Schoenfeld, D. H. Skadden, W. E Thomas, N. D. Wakefield, V. K. Zimmerman.

Associate Professors: G. D. Brighton, C. Weber.

Assistant Professors: J. W. Deskins, E. L. Elliott, F. L. Neumann, R. L. Nolan.

PROFESSIONAL COURSES

501. Accounting Analysis, I. Uses of accounting information; collection, processing, and communication of accounting information; measurement of assets, liabilities, equities, and income; accounting system design. ¾ unit. Deskins.

502. Accounting Analysis, II. An in-depth study of accounting valuation processes and accounting income measurement; special reporting problems of multiple-entity organizations; accounting for nonprofit organizations. ¾ unit. Prerequisite: Accountancy 501 or equivalent. Bedford.

503. Managerial Accounting. Introduction to management accounting as a part of a firm's information system, in terms of modern cost accounting and budgetary systems for planning and controlling business operations. 1 unit. Prerequisite: Credit or registration in Accountancy 501 or equivalent. Holzer.

504. Taxation and Auditing. Introduction to historical and conceptual material in specialized accounting areas of taxation and auditing. Emphasis centered on provisions of the tax law relevant to accounting measurement methods and on nature of evidence in auditing, auditing standards and techniques, and ethical constraints imposed on the auditor. 1 unit. Prerequisite: Accountancy 501, 503, or equivalent. Brighton.

566. Accounting Problems of Industrial Management. A development of the role and importance of cost and revenue data in the process of enterprise administration. Attention is focused on the goals of the firm and the possible aid in achieving these goals that would come from properly conceived, prepared, and utilized cost and revenue data. For Master of Accounting Science and Master of Business Administration students only. 1 unit. Schoenfeld.

577. Professional Problems. Instruction as to types and methods of solution of professional problems in public accounting, including practice in analyzing and solving a wide variety of such problems. For Master of Accounting Science students only. 1 unit. Perry, Skadden.

594. Methods and Practices in Professional Research. Instruction in research methods, materials, and techniques together with individual practice in conducting

and reporting on specific professional research projects. For Master of Accounting Science students only. 1 unit. DESKINS, NEUMANN, ZIMMERMAN.

COURSES FOR GRADUATES

432. Accounting Under Different Social Systems. An inquiry into the ways accounting has been adapted to the needs of different social systems; the extent of its contribution; its apparent limitations. Consideration is also given to the relationship between accounting and the growth and development of social systems. 1 unit. Prerequisite: Consent of instructor. DEMARIS.

441. State and Federal Accounting Theory. Advanced study in accounting and other fiscal procedures of the federal government; state, county, and municipal governments; institutions. 1 unit. LUKAS.

455. Macro-Accounting. Same as Economics 425. An examination of the fundamental concepts underlying the attempts to measure the economic activities of macro-units; similarities and contrasts of accounting problems, theoretical and practical, of the business enterprise and of national or regional units in relationship to existing systems of accounting measurement; macro-accounting statements and analyses; usefulness of macro-accounting techniques and data in evaluating national and regional goals. 1 unit. Prerequisite: Intermediate macro-accounting theory or consent of instructor. ZIMMERMAN.

461. Administrative Accounting. Accounting as a tool for management; organization of accounting department, coordination of departmental operations, control of assets, control of operations, management audits, accounting aspects of coordinating the business with market conditions, cooperation with public accountants and government agencies, and social responsibilities. 1 unit. HOLZER, THOMAS.

462. Management Accounting. An examination of recent conceptual and analytical developments in the area of management accounting. The course includes a study of modern and relevant planning and control techniques and their underlying concepts as applied to the various functional areas within the firm. 1 unit. Prerequisite: An undergraduate course in management accounting. The student's background in statistics and mathematics should be equivalent to the undergraduate requirements of the University of Illinois College of Commerce and Business Administration in these areas. HOLZER, REVSINE.

466. Cost Accounting Theory and Analysis. A critical examination of cost accounting methods as to truth and expediency. 1 unit. DICKEY.

471. Accounting Reports. Form, contents, certificates, comments, consolidated statements, auditor's rights and responsibilities, published corporation reports. 1 unit. WAKEFIELD.

472. Auditing Standards and Techniques. A critical analysis of the techniques used in auditing; interrelation of audit standards, procedures, principles, and techniques; internal control as related to audit techniques; trends and developments in the accounting profession. 1 unit. MAUTZ, MOYER.

473. The Theory of Accounting System Design. Problems and procedures in connection with designing and installing accounting systems. 1 unit. THOMAS.

474. Income Tax Development. A theoretical and historical approach to the study of the development of federal income taxation, together with some research on tax cases and critical appraisal of the current law and proposals for its revision. 1 unit. BRIGHTON, SKADDEN.

475. Accounting Information System Simulation. An examination of the concepts and methodology of simulation, with particular emphasis on the information

system of the firm. A simulation model is developed and used as a basis for deriving information regarding system performance. 1 unit. Prerequisite: Mathematics through calculus, knowledge of computer programming, or consent of instructor. NOLAN.

481. Concepts and Principles. The fundamental structure of accounting theory is developed through the study of concepts characteristic of accounting and an examination of the literature dealing with the concise formulation of accounting principles. 1 unit. BEDFORD, MAUTZ, MOYER.

483. Income Determination. A study of the pros and cons of various unsettled issues involved in the calculation and disclosure of enterprise periodic income. 1 unit. BEDFORD, MAUTZ, NEUMANN.

485. Relationship of Accounting Theory to Philosophy, Science, and Other Disciplines. An examination of the relationship of accounting theory to the developments, thoughts, and methods in the fundamental intellectual disciplines. 1 unit. BEDFORD.

489. History of Accounting Theory. An examination of the more important aspects of accounting theory under the impact of changing conditions over four centuries, with major emphasis on the later developments. 1 unit. ZIMMERMAN.

493. Special Research Problems. Individual investigations or research projects selected by the students, subject to approval by the graduate adviser and the executive officer of the department. ¼ to 2 units. STAFF.

499. Thesis Research. Individual direction and guidance in writing theses, and seminar discussions of progress made. 0 to 4 units. FESS.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. Advanced Accounting. Reserves, sinking funds, actuarial methods, investments, partnerships, statements for special purposes, receiverships, consolidated balance sheets, foreign exchange. ¾ unit. Prerequisite: Accountancy 106 or 166, and 108; an average of C or better in preceding courses in accountancy. BRIGHTON, DUNHAM, PERRY, WAKEFIELD.

325. Accounting System Design. An introduction to the fundamentals of accounting system design. This includes the design and use of business papers, records, and reports; the functions of business machines in accounting systems; and personnel problems in accounting system design. ¾ unit. Prerequisite: Accountancy 308.

341. Governmental Accounting. Accounts of institutions, municipalities, and state and federal governments; organization; procedure, budget, accounts and records, reports, audits. ½ unit. Prerequisite: Accountancy 108. BRIGHTON, DUNHAM.

362. Business Budgets and Accounting Control. Procedures used in the preparation of business budgets and the principles underlying these procedures. A complete budget is prepared by the student for a typical manufacturing company. ¾ unit. Prerequisite: Accountancy 108. HOLZER, SCHOENFELD, THOMAS.

366. Advanced Cost Accounting. Advanced accounting for production management. Principles and methods of accounting for managerial control of costs of production through the use of standards. ½ unit. Prerequisite: Nine hours of accountancy, including Accountancy 106. DICKEY, HOLZER, WEBER.

371. Auditing. Nature of audit evidence, basic audit techniques, audit practices and procedures, professional ethics, audit reports. ¾ unit. Prerequisite: Accountancy 308. FESS, MAUTZ, NEUMANN.

372. **Auditing Problems and Cases.** Application of auditing principles in verification of financial statements; preparation of reports; case studies applicable to specific industries; current trends. ¾ unit. Prerequisite: Accountancy 371. FESS, MOYER, ZIMMERMAN.

374. **Advanced Income Tax Problems.** Practical and theoretical training in the more common and important provisions of the federal income tax, advanced problems, tax case research and preparation. ¾ unit. Prerequisite: Accountancy 274 and 308. BRIGHTON, SKADDEN.

377. **Advanced Problems.** Consolidated statements, foreign subsidiaries, insurance, estates, theory, general statements. 1 unit. Prerequisite: Credit or registration in Accountancy 371. DUNHAM, FESS, PERRY.

378. **Advanced Theory and Practice.** Selected problems from C.P.A. examinations: analysis and revision of statements, partnerships, corporations, quasi-reorganizations, mergers, and others; theory auditing, ethics. 1 unit. Prerequisite: Accountancy 377. PERRY, SKADDEN.

ADVERTISING

The Department of Advertising offers graduate work leading to the Master of Science in Advertising. For the program leading to the Doctor of Philosophy in Communications, see page 142.

Admission to graduate study in advertising requires completion of the requirements for a bachelor's degree in an institution of recognized standing. Furthermore, a grade-point average of at least 4.0 is normally required. Applications of students with grade-point averages below 4.0 are considered on an individual basis. All applicants are urged to take the Graduate Record Examination (GRE).

Master of Science. Requirements for this degree include:

(1) A minimum of eight units (with thesis) or nine units (without thesis).

(2) Four units of advertising, or three units and one additional unit approved by the adviser. Candidates must select at least three units from Advertising 481, 482, 483, or 484. Advertising 381, 382, 383, 384, and 387, or the equivalent, also must be included.

(3) A minimum of two units of non-advertising courses.

(4) A thesis of one unit (in exceptional cases two units may be allowed); or in lieu of a thesis a minimum of nine units of course work.

(5) A minimum of four units of credit at the 400 level in addition to Advertising 499.

GRADUATE FACULTY

Professors: S. W. DUNN (Head of Department), N. WEDDING.
Associate Professors: A. M. BARBAN, H. W. SARGENT.
Assistant Professor: R. H. PYSZKA.

COURSES FOR GRADUATES

481. **Advanced Advertising Principles.** Same as Communications 481. Emphasis is placed on determination and understanding of the principles as related to the science, philosophy, and art of advertising. Students may not receive graduate credit for both Advertising 481 and 388. 1 unit. WEDDING.

482. **Research Methods in Advertising and Communications.** Same as Communications 482. A treatment of basic research concepts and procedures in the social

sciences with emphasis on advertising and communications. Both nonquantitative and quantitative methods are examined. 1 unit. DUNN, PYSZKA.

488. Advertising and the Mass Media. Same as Communications 488. Functions of mass media as carriers of advertising messages; quantitative and qualitative audience research and analysis; formulation of media plans to achieve specific communications objectives. 1 unit.

484. Advertising and Consumer Behavior. An examination of consumer behavior as a means of shaping the communications message; use of the behavioral sciences in creative communication strategy. 1 unit. BARBAN.

490. Special Topics in Advertising. ½ or 1 unit. Prerequisite: Consent of head of department. STAFF.

499. Thesis Research. 1 to 2 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

309. Public Relations. Publicity methods and public relations; representation of business and other sponsors to the public and representation of the public to employers. Preparation of public relations units for the press and other media. ½ unit.

381. Advertising Research Methods. Quantitative techniques and research methodology in advertising; philosophy of science, statistical methods, survey and experimental design, etc. Emphasis is on the problems of advertising research. ½ unit. Prerequisite: Advertising 281. PYSZKA.

382. Advertising Creative Strategy. Theory and practice of advertising message planning and creation for print and broadcast media; use of consumer and market surveys, copy-testing methods, and advertising readership studies. ½ unit. Prerequisite: Advertising 281. SARGENT.

383. Advertising Media Policy and Strategy. Analysis of the various advertising media in terms of markets served and factors to consider in the selection of media. ½ unit. Prerequisite: Advertising 281. BARBAN, PYSZKA.

384. Advertising Campaigns. Planning and execution of an advertising campaign; market and consumer research; development and allocation of advertising budget, organization and functions of advertising agency, choice of advertising appeals; selection of media; preparation of advertisements—copy and layout. ½ unit. Prerequisite: Advertising 382 and 383, or consent of instructor.

387. Advertising and Promotion Management. Analysis of actual advertising situations and study of how such situations were or might have been met. Emphasis is given to management decision-making problems at the national level. ½ unit. Prerequisite: Advertising 281. WEDDING.

388. Advertising in Contemporary Society. A study of advertising as an institution and its role in communications, society, our economy, and business. Students may not receive graduate credit for both Advertising 388 and 481. ½ unit. Prerequisite: Advertising 281. SARGENT.

389. International Advertising and Promotion. The role of advertising and promotion in international communication and economic development; behavioral science approach to international communications strategy; comparative analysis of advertising and promotion systems. ½ unit. Prerequisite: Advertising 281. DUNN.

390. Advanced Creative Strategy. Advanced work in application of behavioral sciences and creative process to planning and writing of advertisements. ½ unit. Prerequisite: Advertising 382 or consent of instructor.

AERONAUTICAL AND ASTRONAUTICAL ENGINEERING

The Department of Aeronautical and Astronautical Engineering offers graduate programs leading to the Master of Science and Doctor of Philosophy. Study and research are planned to prepare graduates for fundamental and applied work in airplane, missile, and space flight engineering. Typical areas of concentration are aerodynamics, aeroelasticity, astrodynamics, propulsion, structural mechanics, and guidance and control.

The minimum grade-point average for admission to graduate study in aeronautical and astronautical engineering is 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

The prerequisite for graduate study in aeronautical and astronautical engineering normally is the equivalent of the undergraduate courses required at the University of Illinois for a bachelor's degree in aeronautical and astronautical engineering; however, graduates of curricula leading to degrees in other fields of engineering, the physical sciences, or mathematics may also be admitted to advanced study.

Candidates for the degree of Master of Science are required to have a minimum of eight units of graduate work, including a thesis.

Because of the wide range of interests in the field of aeronautical and astronautical engineering, there are no specific course requirements for a major in the program of study leading to the degree of Doctor of Philosophy. Each student plans his study program in consultation with a departmental adviser. Courses offered by departments other than aeronautical and astronautical engineering may be included in the major area of study when these courses are of particular value to the work which students desire to emphasize. The major and minor programs must meet with the approval of the head of the department.

Graduate students who desire to minor in aeronautical and astronautical engineering must have taken mathematics through the first course in differential equations and the undergraduate aeronautical and astronautical engineering courses, or their equivalents, which are prerequisites to study in the area of the minor work. Deviation from these requirements requires approval from the head of the department.

For information concerning applied mathematics, see page 307.

GRADUATE FACULTY

Professors: H. S. Stillwell (Head of Department), B. L. Hicks, H. H. Hilton, H. W. Knoebel, Y. K. M. Lin, R. W. McCoy, A. I. Ormsbee, R. A. Strehlow, S. M. Yen, A. R. Zak.
Associate Professors: H. O. Barthel, C. E. Bond, K. R. Sivier.
Assistant Professor: L. H. Sentman.

COURSES FOR GRADUATES

411. Advanced Aerodynamics of Compressible Fluids. Advanced aerodynamic theory of compressible fluids in the subsonic and supersonic velocity ranges. 1 unit. Ormsbee.

414. Boundary Layer Theory. Theories of the boundary layer of a compressible fluid and their solutions, laminar and turbulent; boundary layer in hypersonic flow. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 213. Yen.

415. Wing Theory. Theoretical analysis of the aerodynamic characteristics of two- and three-dimensional wings and multiple body systems in subsonic and supersonic flow. 1 unit. Prerequisite: Mathematics 346 or equivalent. Ormsbee.

416. Hypersonic Aerodynamics. Discussion of high Mach number flows including the aerodynamic effects of dissociation and ionization. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 411. ORMBSEE.

417. Fundamentals of Gas Kinetics. Fundamental concepts required to study gas theory: derivation of the Boltzmann equation from classical mechanics; reduced and truncated distribution functions and the BBGKY hierarchy; molecular collisions; flux vectors, equations of change; moment equations; summational invariants; H-theorem and Maxwellian distribution; inclusion of the effect of solid surfaces in kinetic theory; existence theory for the Boltzmann equation; iteration procedures; moment methods; Chapman-Enskog procedure; first and second approximations to the distribution function, the heat flux vector, and stress tensor. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 213. SENTMAN.

418. Theory of Rarefied Gas Flows. Application of kinetic theory to rarefied gas flow problems; free-molecule flow; near free-molecule flow; linearized problems; flows with appreciable deviation from equilibrium. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 417 or Physics 362. YEN.

428. Theory of Large Deformations in Nonlinear Continuous Media. Fundamental concepts of large deformations in nonlinear elasticity and inelasticity with applications: generalized tensors, finite deformations, stress-strain relations in terms of strain energy functions, solutions of tension, shear and bending problems, finite plane strain, theory of successive approximations, fiber reinforced beams, plates and cylinders, thermodynamics of deformable media, stability considerations, constituent relations for inelasticity. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 326 or equivalent. HILTON.

429. Theory of Linear and Nonlinear Viscoelasticity. Fundamental concepts of viscoelasticity with applications. Elastic-viscoelastic analogies, creep and relaxation functions, thermo-mechanical reciprocity relations, variational principles, model fitting, shear center motion, thick-walled cylinders under pressure and inertia loads with material annihilation, sandwich plates, propagation of viscoelastic waves, vibration of bars, plates and shells, nonlinear elastic-viscoelastic analogy, properties of nonlinear viscoelastic stress-strain laws, creep rupture, torsion of nonlinear bars and shells. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 326 or consent of instructor. HILTON.

434. Aerodynamic Heating. Theory of convective aerodynamic heating in high-speed flow, laminar and turbulent flows; ablation, transpiration cooling, and mass transfer cooling; aerodynamic heating in hypersonic flow, real gas effects, effect of pressure interactions and vorticity interactions; heat transfer in rarefied gas flows. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 414 or equivalent. YEN.

438. Fundamentals of Combustion. Same as Mechanical Engineering 403. Fundamentals of kinetic theory, transport phenomena, chemical equilibria, and reaction kinetics; flames, their gross properties, structure, and gas dynamics including oscillatory and turbulent burning; solid and liquid propellant combustion; one-dimensional detonation theory including structure and initiation; three-dimensional and other complex detonation waves; supersonic burning. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 213 or Mechanical Engineering 305. STREHLOW.

452. Stochastic Structural Dynamics. Linear structural dynamics problems treated from a probabilistic point of view; axiomatic probability theory and random processes; the response of linear structures to random excitation; practical problems in aeronautical and astronautical engineering. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 255 or Theoretical and Applied Mechanics 412, or equivalent. LIN.

453. Stochastic Processes in Engineering. Same as Electrical Engineering 438. This course supplements Aeronautical and Astronautical Engineering 452 or Electrical Engineering 434 for additional engineering applications of stochastic processes. Theories of random pulses and continuous Markov processes and their applications to dynamic and control systems; parametric excitations and stability; nonlinear devices; topics related to system failures. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 452, Electrical Engineering 434, or equivalent. LIN.

490. Seminar. Presentation by graduate students and staff of current topics in the fields of aeronautics. No credit. Prerequisite: Graduate standing in aeronautical and astronautical engineering. SENTMAN.

493. Special Problems. Theoretical and experimental investigations of problems in airplane, missile, and space flight engineering. 1 to 2 units. STAFF.

499. Thesis Research. Research in the various areas of the aeronautical and astronautical sciences. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

306. Foundations of Mechanics and Gravitational Theory. Same as Astronomy 306. Introduction to the dynamics of particles and of rigid bodies with special emphasis on elementary planetary motion, motion of a rocket, motion of long-range projectile relative to Earth, precession of Earth's axis, etc. 1 unit. Prerequisite: Mathematics 142 or 143. MCVITTIE, STILLWELL.

317. Elements of Magnetohydrodynamics. Same as Astronomy 317. Equations of magnetohydrodynamics, single-fluid and multiple-fluid models, magnetic interaction parameters, magnetosonic waves, hydromagnetic shock waves, aligned-field and cross-field flows, theory of characteristics, MHD acceleration, generation, and propulsion. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 213 or consent of instructor. BOND.

326. Theory of Continuous Media. Introduction to the general theory of continuous media and its application to the theories of elasticity, fluid mechanics, and inelasticity. Stress and strain tensors and their invariants; nonlinear strain relations; nonlinear equilibrium conditions; the mechanism of deformation of single crystal and polycrystalline media; basic concepts of the structure of matter; thermodynamic considerations; equations of state and stress-strain relationships with applications. 1 unit. Prerequisite: Consent of instructor. HILTON.

327. Thermal Stresses and Creep Buckling. Structural effects of aerodynamic heating; analysis of thermal stresses in elastic, viscoelastic, and plastic media; effect of temperature dependent material properties on thermal stresses; analytical studies of creep buckling due to axial loads and heating of plastic and linear and nonlinear viscoelastic columns, plates, and shells; life expectancy of structures under elevated temperatures; minimum weight and probability of failure; applications to high-speed airplane, missile, and space vehicle structures. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 326 or consent of instructor. ZAK.

334. Rocket Propulsion and Rocketry. The basic principles of rocket propulsion and rocketry are treated. Propellants and their influence on design of rockets, internal and external ballistics, combustion processes, design of components, guidance problems, flight performance, and rocket testing are discussed in detail. ½ unit. Prerequisite: First course in thermodynamics or consent of instructor. MCCLOY.

351. Aeroelasticity and Aeroinelasticity. Advanced fundamental treatment of aerodynamic and dynamic structural phenomena associated with flexible airplanes and missiles; divergence of linear and nonlinear elastic lifting surfaces; effect of elastic and inelastic deformations on lift distributions and stability; elastic flutter of straight and swept wings; equations of disturbed motion of elastic and inelastic aircraft; dynamic response to forces, gusts, and continuous atmospheric turbulence; creep divergence of lifting surfaces; flutter in the presence of creep; effect of temperature on inelastic divergence and flutter. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 255. ZAK.

391. Special Problems. Special problems relating to the theory, design, testing, operation, maintenance, or production of airframes or aircraft power plants. ½ or 1 unit. Prerequisite: Consent of instructor. STAFF.

AGRICULTURAL ECONOMICS

(Including Rural Sociology)

Graduate students may take work in agricultural economics leading to the Master of Science and Doctor of Philosophy. Fields of specialization include farm management, land economics, agricultural prices and marketing, agricultural finance, agricultural policy, international economic development, consumption economics, agricultural law, and rural sociology.

Students who desire to secure degrees in agricultural economics must have completed a course of study equivalent to a baccalaureate degree which includes twelve hours of agricultural economics and economics.

Students who desire to specialize in rural sociology should have had a minimum of six hours of sociology.

The grade-point average required for admission to graduate study in agricultural economics is 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

A candidate for the Master of Science degree is required to register for at least two units of economics, including one unit of economic theory. For the Doctor of Philosophy degree, a candidate must complete a minimum of (1) three units in economics, including one unit each of micro and macro theory, both at the 400 level; (2) one 300- or 400-level course in each of two areas in agricultural economics in which preliminary examinations are not written; and (3) two and one-half units in quantitative methods and research methodology. Equivalent courses are accepted in fulfillment of these requirements, subject to Graduate College regulations.

If approved by the Department of Agricultural Economics, the required work in economics may be treated as a part of the major field.

To take agricultural economics as a minor, the student must complete two units of course work in agricultural economics for a M.S. degree or four units for a Ph.D.

GRADUATE FACULTY

Professors: H. G. HALCROW (Head of Department), C. B. BAKER, R. W. BARTLETT, G. K. BRINEGAR, E. E. BROADBENT, B. L. BROOKS, W. D. BUDDEMEIER, F. DOVRING, F. C. FLIEGEL, C. L. FOLSE, H. W. HANNAH, T. A. HIERONYMUS, J. M. HOLCOMB, J. A. HOPKIN, G. G. JUDGE, R. A. KELLY, N. G. P. KRAUSZ, R. J. MUTTI, F. J. REISS, R. G. SPITZE, E. R. SWANSON, T. TAKAYAMA, W. N. THOMPSON, R. N. VAN ARSDALL, V. I. WEST, S. W. WILLIAMS, J. E. WILLS.

Associate Professors: L. P. FETTIG, J. H. HERBST, L. D. HILL, R. A. HINTON, M. B. KIRTLEY, A. G. MUELLER, J. R. ROUSH, S. C. SCHMIDT, H. J. SCHWEITZER, J. T. SCOTT, D. G. SMITH.

Assistant Professors: J. W. GRUEBELE, W. D. SEITZ.

Agricultural Economics

COURSES FOR GRADUATES

401. International Comparative Agriculture. Agricultural and food problems of the world and of selected countries viewed in the world setting; resources and institutional factors affecting production; national and international policies and plans for developing agricultural production and improving levels of living. Emphasis is given to a comparative approach to agricultural development of countries on different economic levels. 1 unit. DOVRING.

404. Economics of Agricultural Production. Evaluation of efficiency in the use of agricultural resources; production relationships within the farm; adaptation of the farm business to uncertainty; production relationships among farms; location of agricultural production. 1 unit. Prerequisite: Economics 200 or 300 and Agricultural Economics 341 or consent of instructor. SWANSON.

405. Economic Policies and Programs Affecting Agriculture. Economic analysis of state, national, and international policies and programs, including proposed legislation having important bearing on the well-being of farm people. 1 unit. Prerequisite: One semester of graduate work or consent of instructor. GUITHER, HALCROW, SCHMIDT.

406. Research Methodology in Agricultural Economics. Methods of inquiry leading to information which is reliable and relevant to the solution of problems significant in the agricultural economy. 1 unit. Prerequisite: Economics 400 or 401, or a course of comparable level in the basic field related to the student's research. BAKER.

425. Farm Management Principles. Analysis of farm business records; evaluation of measures of efficiency; planning the cropping system for increased income and control of erosion; use of economic information in fitting livestock to the farm plan; efficient use of labor and power; special research problems in farm organization. 1 unit. SCOTT.

436. Problems in Marketing Agricultural Products. Factors influencing growth of markets; methods of reducing costs and improving marketing processes; activities of governmet agencies; cooperative efforts. 1 unit. BRINEGAR, HILL.

441. Agricultural Statistics. Sources and methods of collection and analysis of prices and other agricultural statistics; trend fitting, linear and curvilinear multiple correlation, analysis of variance and sampling. 1 unit. Prerequisite: An elementary course in statistics. WEST.

442. Quantitative Analysis in Agricultural Economics. Application of techniques of quantitative analysis in agricultural economics; construction, estimation, and interpretation of sector, spatial, and input-output models for the agricultural economy. 1 unit. Prerequisite: Agricultural Economics 441, Economics 401, and Mathematics 315. JUDGE.

470. Seminar in Family and Consumption Economics. Same as Home Economics 470. Discussion of current topics and review of the literature in family and consumption economics. ½ or 1 unit. Prerequisite: Economics 102 or 108 and a course in statistics; Agricultural Economics 370 or consent of instructor. DUNSING.

491. Seminar and Special Topics. All graduate students majoring in agricultural economics must register in the noncredit section of this course. In addition, students may register for credit for individual research or group instruction on special topics under the supervision of one or more staff members. 0 to 2 units.

499. Thesis Research. Individual research under supervision of members of the graduate teaching staff in their respective fields. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Economics of Agricultural Development. The economics of agriculture and the relationships between agriculture and other sectors of the economy in developing nations; agricultural productivity and levels of living in the less developed areas of the world; studies of agricultural development in different world regions, including Africa, Asia, and Latin America. ¾ or 1 unit. Prerequisite: Economics 103 or 108. DUE, THOMPSON.

302. Financing Agriculture. Capital and credit needs of farmers; agencies supplying credit; problems of borrowers and lenders. ¾ or 1 unit. Prerequisite: Economics 102 or 103, or 108. BAKER, HOPKIN.

303. Agricultural Law. Relation of common law principles and statutory law to land tenure, farm tenancy, farm labor, farm management, taxation, and other problems involving agriculture. ½ to 1 unit. HANNAH, KRAUSZ.

305. Agricultural Policies and Programs. The problems of agriculture as an industry and an analysis of past and current federal and state governmental policies and programs affecting agriculture; objectives and development of policies; the use of economic concepts in evaluating possible future agricultural policies and programs; and forces in policy formation. Field trip; expense, $10.00. ¾ or 1 unit. Prerequisite: Economics 108. GRUEBELE, SCHMIDT, SPITZE.

312. Farm Appraisals. Same as Agronomy 312. Valuation methods and value bases of farm real estate. Includes legal aspects of appraisal work, appraisal theory and procedures, condemnation appraisal, characteristics of the farmland market, engineering and agronomic data for farm appraisals, and practice appraisals. Seven field trips; expense about $10.00. 1 unit. Prerequisite: Agronomy 101 and Agricultural Economics 220, or equivalent. REISS, STAFF.

318. Land Economics. Physical, economic, and institutional factors that affect the role of land in economic life; population and resource requirements; principles of land utilization; returns from land; land value; property rights and tenure rights; social controls; rural and urban land development. ¾ or 1 unit. Prerequisite: Consent of instructor. DOVRING.

324. Farm Operation. Operating costs in farming, analysis of farm jobs, farm work simplification, selecting power units and equipment for economical operation. Field trips; estimated expense, $5.00. ¾ or 1 unit. Prerequisite: Agricultural Economics 200. HINTON, VAN ARSDALL, WILLS.

325. Advanced Farm Management. The functions of management; effects of goals and values on management decisions; use of economic analysis in farm production planning including resource allocation and valuation, and cost minimization. ¾ or 1 unit. Prerequisite: Agricultural Economics 220. SCOTT.

326. Professional Farm Management. Principles of farm management applied to the problems of those managing farms for others as a profession; development of the profession; relationships with clients and farm operators; division of inputs and returns between owner and operator; direct operation of farms with hired labor; case problems; business practices and procedures; professional ethics. Field trips to farms and professional farm management offices; estimated expense, $25.00. ¾ or 1 unit. Prerequisite: Credit or registration in Agricultural Economics 324; Agricultural Economics 325. HOLCOMB, SMITH.

331. Grain Marketing. Economic and marketing problems in grain; the utilization of grain; pricing arrangements for grain, especially future markets; inventory

management, operational problems at country and interior points; factors affecting grain prices; seasonal variation in grain prices. Field trips; estimated expense, $10.00. ¾ or 1 unit. Prerequisite: Agricultural Economics 230 or an elementary marketing course. BROOKS, HIERONYMUS.

332. Livestock Marketing. Same as Animal Science 332. Economic principles applied to marketing livestock and livestock products from the standpoint of producers, processors, and distributors; theoretical basis for evaluating alternative market-systems and functions; evaluation of changes in the industry affecting marketing decisions. Field trip; estimated expense, $15.00. ¾ or 1 unit. Prerequisite: Economics 108; Agricultural Economics 230 or an elementary marketing course. BROADBENT.

334. Marketing of Dairy Products. Same as Dairy Science 334. Economic interrelationships of various dairy products; collective bargaining; federal milk orders, mark-up laws, marketing quotas, and other governmental regulations; lowering distribution costs; factors affecting demand and consumption; expanding markets for dairy products. Inspection trip; estimated expense, $5.00. ¾ or 1 unit. Prerequisite: Agricultural Economics 230 or an elementary marketing course, or twelve hours of dairy science or dairy technology. GRUEBELE.

335. Economics of Food Distribution. Same as Horticulture 335. Analysis of (1) marketing structures and operations in the manufacture and wholesale and retail distribution of food; (2) effects of industry organization and governmental regulations on marketing functions and efficiency; (3) consumer demand for food. ¾ or 1 unit. Prerequisite: Economics 108; Agricultural Economics 230 or an elementary marketing course. KELLY.

337. Economic History of American Agriculture. Same as Economics and History 337. The development of American agriculture from early colonial times to the present. Emphasis on regional development, evolution of methods and equipment, trends in marketing and credit, and the making of federal farm policy. ½ or 1 unit. Prerequisite: A college-level course in basic economics or American history. GUITHER.

341. Agricultural Economic Statistics. Graphic presentation, frequency distribution, inference and probability, time series analysis, index numbers, analysis of variance, correlation, and simple and multiple regression as applied to agricultural economics. ¾ or 1 unit. Prerequisite: Mathematics 111 or 112, or equivalent. SCOTT.

342. Agricultural Prices. A study of the factors affecting prices of agricultural products; long-time, cyclical, seasonal, and other price movements; sources of information relating to production and demand factors; government activities as they relate to prices of agricultural products and problems in price analysis and forecasting. ¾ or 1 unit. Prerequisite; Economics 103 or 108. SCHMIDT, SIMERL.

370. Family Economics. Same as Home Economics 370. Economic welfare of American families in terms of cost of living, standard of living, income, and net worth. ½ or 1 unit. Prerequisite: Economics 102 or 108; a course in applied statistics. DUNSING.

Rural Sociology

COURSES FOR GRADUATES

407. Population Studies and Demographic Analysis. Same as Sociology 407. Nature and development of population theories; population growth and measures o

fertility, reproduction, mortality, morbidity, and internal migration; indices, rates, and standardizations used in analyzing compositional characteristics. Methods in population projections; relationship of economic, sociological, and psychological factors to population changes. 1 unit. Prerequisite: Twelve hours of social science and introductory statistics, or major in sociology, or consent of instructor. FOLSE.

477. Seminar on Community Organization. Same as Sociology 477. Theories relating to the community concept and the analysis of community organization; the process of community change as applied to societies in various parts of the world. 1 unit. Prerequisite: Sociology 275 or consent of instructor. FLIEGEL.

487. Special Problems in Rural Sociology. Same as Sociology 487. ½ or 1 unit. Prerequisite: One unit of graduate credit in sociology; consent of instructor. STAFF.

AGRICULTURAL EDUCATION

This program leads to the Master of Science in Agricultural Education and is open only to students who have met the requirements for teaching agriculture. It has been planned as a fifth year of work for students who have completed the requirements of the four-year general agriculture curriculum with major for teachers of agricultural occupations, or its equivalent. Candidates must earn four units in agriculture, two units in education, and two units in electives. The two units in education must include Educational Psychology 311 and 312, and History and Philosophy of Education 304 and 305. The courses in agriculture and the electives must be selected with the approval of the student's adviser. The electives may be in agriculture, in education, or in exceptional cases, in other fields.

A minimum of four units must be taken in residence. A maximum of four of the required eight units may be earned in extramural courses offered by the University of Illinois; of these four units, no more than two units may be in technical agriculture and no more than two units may be in education.

In order to fulfill one of the objectives of this program, that of broad general training in technical agriculture at the graduate level, the agriculture courses and electives must be selected with the approval of the adviser. In general, agriculture courses are selected from at least three subject-matter departments with no more than three units from any department.

The minimum grade-point average for admission to graduate study in agricultural education is 3.5. See pages 20 to 25.

Advisers for candidates for this degree are Assistant Dean C. D. Smith, 104 Mumford Hall; Professor Lloyd J. Phipps, 357a Education Building; and other members of the staff of the Division of Agricultural Education, College of Education.

AGRICULTURAL ENGINEERING

(Including Agricultural Mechanization)

The Department of Agricultural Engineering offers graduate work leading to the Master of Science and Doctor of Philosophy degrees with a major in agricultural engineering. The student may specialize in field power and machinery (soil dynamics, tillage and earthmoving, operations analysis, dynamics of particles and mechanisms, accelerated drying, and vehicle stability); soil and water mechanics (hydraulics of structures, agricultural hydrology, drainage, mechanics of erosion, and water resources planning); farm structures (structural analysis and design, environmental control, air contaminates, and waste disposal); or electric power and

processing (system analysis for farmstead mechanization, crop processing, and physical properties of agricultural products).

The grade-point average required for admission to graduate study is 4.0 for the last sixty hours of undergraduate work; however, applications of those with averages below 4.0 but above 3.75 are reviewed individually by the departmental graduate committee and admission may be recommended if credentials are satisfactory.

Candidates for the master's degree must have the equivalent of the undergraduate curriculum at the University of Illinois.

Candidates for the Doctor of Philosophy must fulfill all the standard requirements of the Graduate College as noted on pages 39 to 41. The program provides for a major in agricultural engineering with a minor in other graduate departments of engineering, mathematics, physics, including soil physics, or other disciplines in the physical sciences.

Opportunity for independent study and research is an important part of both the Master of Science and the doctorate programs. Research opportunities are available in both the Agricultural and Engineering Experiment Stations. For the master's degree, a thesis involving an analytical or experimental investigation and satisfying about one-fourth of the credit for the program is normally required.

Inquires concerning graduate work should be directed to Frank B. Lanham, Head of the Department, 245 Agricultural Engineering Building.

GRADUATE FACULTY

Professors: F. B. Lanham (Head of Department), H. H. Beaty, E. L. Hansen, R. C. Hay, D. R. Hunt, B. A. Jones, Jr., J. W. Matthews, E. F. Olver, J. A. Weber, R. R. Yoerger.

Associate Professors: B. J. Butler, J. O. Curtis, D. L. Day, H. B. Puckett, G. C. Shove, J. C. Siemens.

Assistant Professors: R. F. Espenschied, G. E. Hall, W. R. Nave.

Agricultural Engineering

COURSES FOR GRADUATES

400. Research Orientation. Discussion of the philosophy and methods of research, thesis preparation, and publication of research findings. No credit.

436. Dynamics of Farm Machine Elements. Advanced study of the dynamics of farm machine elements with specific reference to functional operation, stresses, and fatigue life. 1 unit. Prerequisite: Agricultural Engineering 236 and 336, or equivalent. Yoerger.

440. Design and Analysis of Biological Experiments. Same as Agronomy, Animal Science, Dairy Science, Food Science, Forestry, Horticulture, and Veterinary Medical Science 440. Statistical methods as tools for research. Principles of designing experiments and methods of analysis for various kinds of designs, including factorial experiments, are considered from the viewpoint of when and how to use them. ¾ unit. Prerequisite: Agricultural Engineering 340 or equivalent.

441. Advanced Design and Analysis of Biological Experiments. Same as Agronomy 441. Design and analysis of complex experiments. Confounded factorials, lattice designs, and other incomplete-block experiments are considered from the viewpoint of their characteristics, methods of analysis, and usefulness in biological research. ½ unit. Prerequisite: Agricultural Engineering 440 or equivalent.

446. Dynamics of Tillage, Traction, and Earthmoving. Relationship of soil parameters to forces acting on tillage tools, earthmoving components, and traction devices; stress strain relationships in soil, failure patterns, and pulverization; speed effects, energy requirements, power trains, and model simulation. 1 unit. Prerequisite: Bachelor of Science degree in engineering or consent of instructor. WEBER.

490. Seminar. Presentation and discussion of current research and literature in agricultural engineering. ¼ unit.

496. Problems in Agricultural Engineering. Investigation and report on problems in farm machinery, farm power, rural electrification, soil and water control, rural housing and farm structures. 1 unit. Prerequisite: Consent of head of department. STAFF.

499. Thesis Research. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. Instrumentation and Measurements. Same as Mechanical Engineering 311. Accuracy, precision, and statistical consideration of measurement data; dynamics of measurement; displacement, velocity, acceleration, force, torque, pressure, and temperature measurements; mechanical impedance; measurements on fluids; instrumentation systems. ¾ or 1 unit. Prerequisite: Senior standing in engineering or science. YOERGER.

336. Design of Agricultural Machinery. Determining machine requirements and specifications, design layout, effective use of materials and shapes, relation of design to problems. ½ unit. Prerequisite: Mechanical Engineering 224; Agricultural Engineering 236. HUNT.

340. Introduction to Applied Statistics. Same as Agronomy, Animal Science, Dairy Science, Food Science, Forestry, Horticulture, and Veterinary Medical Science 340. Statistical methods involving relationships between populations and samples; collection, organization, and analysis of data; techniques in testing hypotheses with an introduction to regression, correlation, and analyses of variance limited to the completely randomized design and the randomized complete-block design. ¾ unit. Prerequisite: Mathematics 104 or 111 or 112, or equivalent.

346. Tractors and Prime Movers. Engineering aspects of design and application of tractors for farm, construction, and military use; thermodynamics of engines, turbines, and other power units; measurement of power and efficiencies, transmission of power, traction, stability, and hydraulic circuitry. ¾ unit. Prerequisite: Mechanical Engineering 209, Agricultural Engineering 146, or equivalent. WEBER.

356. Soil Conservation Structures. Hydrology, hydraulics, design, construction, and cost estimating of soil and water conservation structures; relationship of slopes, soils, crops, and practices in soil conservation and flood control. ½ unit. Prerequisite: Theoretical and Applied Mechanics 235; Agricultural Engineering 277 or equivalent. JONES.

357. Land Drainage. The design, construction, performance, and maintenance of surface, tile and open ditch drainage systems. ½ unit. Prerequisite: Theoretical and Applied Mechanics 235. JONES.

376. Advanced Design of Farm Structures. Timber, steel, and concrete building design, with emphasis on structures for agricultural production. ½ unit. Prerequisite: Civil Engineering 262; Agricultural Engineering 277 or equivalent. CURTIS.

387. Agricultural Process Engineering. Principles, design factors, equipment, and controls of systems for drying, refrigerating, reducing, pelleting, blending, cleaning, sorting, and treating agricultural crops and products. ½ unit. Prerequisite: Agricultural Engineering 286 or Chemical Engineering 363. SHOVE.

396. Special Problems. Individual investigation and report of any phase of agricultural engineering approved by the department. ¼ to 1 unit. Prerequisite: Senior standing in engineering.

Agricultural Mechanization

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Special Problems. An agricultural problem with engineering implications is selected for study, investigation, and report, wherein a satisfactory solution does not require a background in engineering education. ¼ to 1 unit. Prerequisite: Minimum grade-point average of 3.5; consent of instructor and head of department. Specific approval of the associate dean in advance of registration is required for a second special problems course. STAFF.

331. Farm Machinery Technology. Application, functional operation, and management of tillage, planting, chemical application and harvesting machinery, incorporating current engineering, agronomic, and biological research results. For students presently in or preparing for teacher training or extension education. ¾ unit. Prerequisite: Agricultural Mechanization 112 or 221. BUTLER.

361. Development and Function of Family Housing. Same as Home Economics 361. Study of principles and problem solutions in family housing; basic functions, plan patterns, types, materials, and structure; economic influences, costs, and adaptations; personal and public interest. ¾ unit. HANSEN.

381. Electro-Mechanical Agricultural Systems. Application of electric power and mechanical equipment to livestock production, crop conditioning, and materials handling systems; for efficient use of time, power, and labor. Principles of planning materials handling systems; requirements for environmental control in agricultural production; electric controls circuits; and factors affecting drying, cooling, and processing of crops. ¾ unit. Prerequisite: Agricultural Mechanization 281 or graduate standing in agriculture. BEATY.

AGRONOMY

The Department of Agronomy offers graduate work leading to the Master of Science and Doctor of Philosophy in Agronomy. The student may specialize in (1) crops: breeding and genetics, crop evolution, crop production, biometry, forage crops, morphological development, physiology, plant chemistry, weeds and their control; or (2) soils: biology, chemistry and biochemistry, fertility, genesis, morphology and classification, managment, physical and colloidal chemistry, physical edaphology, physics.

The student must show promise of achievement in his chosen field, must have a grade-point average of 3.75 or higher for the last sixty semester hours of work completed, and must be approved by the Department of Agronomy. For students having grade-point averages below 4.0 but above 3.75, only those having unusually strong training in the basic sciences are considered for admission.

Adequate preparation for graduate work in soils includes courses in physics, chemistry, geology, microbiology, and mathematics; and in crops, courses in botany, chemistry, genetics, and statistics.

A candidate for the Master of Science must present an acceptable thesis, unless this requirement is waived by petition, and pass an oral examination.

Agronomy courses totaling four units fulfill the requirements for a first minor for the Doctor of Philosophy.

GRADUATE FACULTY

Professors: M. D. Thorne (Head of Department), S. R. Aldrich, D. E. Alexander, A. H. Beavers, C. M. Brown (Associate Head of Department), A. W. Burger, J. M. DeWet, E. B. Earley, J. B. Fehrenbacher, J. W. Gerdemann, J. E. Gieseking, H. H. Hadley, R. H. Hageman, J. B. Hanson, J. R. Harlan, C. N. Hittle, A. L. Hooker, J. A. Jackobs, R. W. Jugenheimer, A. Klute, L. T. Kurtz, J. R. Laughnan, E. R. Leng, S. W. Melsted, R. T. Odell, J. W. Pendleton, D. B. Peters, M. B. Russell, W. O. Scott, F. W. Slife, F. J. Stevenson, E. H. Tyner.

Associate Professors: R. L. Bernard, S. G. Carmer, R. L. Cooper, J. W. Dudley, R. L. Jones, E. L. Knake, D. A. Miller, R. J. Miller, R. J. Millington, R. W. Rinne, E. C. A. Runge, B. R. Sabey, R. D. Seif, R. O. Weibel, L. F. Welch, C. M. Wilson, J. T. Woolley.

Assistant Professors: O. C. Braids, T. D. Hinesly, T. Hymowitz, R. J. Lambert, M. D. McGlamery, J. E. Molina, W. L. Ogren, E. B. Patterson, B. W. Ray, W. M. Walker, L. M. Wax, Evelyn J. Weber, J. M. Widholm.

COURSES FOR GRADUATES

400. Seminar. Discussions of current literature in crops and soils. Required of all graduate majors in agronomy. No credit. Staff.

402. Chemical Properties of Soil: Their Relations to Soil Development and Plant Growth. Chemical properties of soils and soil materials; their significance in soil development and in growth and nutrition of crop plants. Lectures, discussions, assigned reading, and bibliography. 1 unit. Prerequisite: Agronomy 101; Chemistry 101, 102, or 122, or equivalent. Melsted.

403. Genesis, Morphology, and Classification of Soils. Historical review of work in soil genesis; genetic factors of soil formation; soil-forming processes and reactions; classification and nomenclature of soils; properties and distribution of the major soil groups of the world. Assigned reading. ¾ unit. Offered in 1970-1971 and in alternate years. Prerequisite: Agronomy 301 or consent of instructor. Fehrenbacher.

405. Colloidal Chemistry of Soils. Soil components, their nature, and their influence on the physical, chemical, biological, and electrokinetic properties of soils. Lectures, discussions, and assigned reading. 1 unit. Prerequisite: Chemistry 340 and 341, or equivalent. Gieseking.

411. Soil Physics. The derivation and application of the fundamental physical principles and laws which govern the behavior of soils. Transport phenomena and physical characteristics of soils are emphasized. Lectures, discussions, and assigned readings. 1 unit. Prerequisite: One year of calculus. Klute.

412. Soil Organic Matter. Basic considerations in organic matter transformation; geochemistry of organic matter; nature and origin of humic substances; reactions of organic matter in soils and sediments. Lectures, discussions, and assigned readings. 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Agronomy 309 or consent of instructor. Stevenson.

414. Physical Chemistry of Clays and Soils. Same as Mining Engineering and Ceramic Engineering 414. The application of physical chemical principles and concepts to surfaces and adsorption on surfaces. Silicate surfaces and water adsorption are emphasized. 1 unit. Prerequisite: Chemistry 340 and 341, or equivalent, or consent of instructor. R. J. MILLER.

422. Pasture, Range, and Soil Conservation Research. Discussion and study of data and literature pertaining to pastures, range, and soil conservation; application of research methods to the evaluation of forage species in the management and utilization of pasture and range and to soil conservation. 1 unit. Prerequisite: Agronomy 121, 321, or 322. HITTLE.

423. Cytogenetic and Evolutionary Basis of Plant Breeding. Nature and origin of crop species; genetic and cytogenetic basis for developing special plant materials and the use of such materials in breeding programs. Emphasis on discontinuous variation. 1 unit. Prerequisite: Agronomy or Horticulture 323, or equivalent, or consent of instructor. HADLEY.

424. Mineral Nutrition of Plants. Same as Botany and Horticulture 424. A study of the uptake, transport, and metabolic utilization of mineral nutrients by plants. The scope of the course is to present the essentiality of various anions and cations in the light of metabolic activity and constituency in functional plant compounds. Major emphasis is placed on metabolic activity and function of the elements. 1 unit. Prerequisite: Botany 330 or consent of instructor. HAGEMAN.

429. The Evolution of Agricultural Economies. Same as Anthropology and Geography 429. The problems concerning the development of the several basic food crop economies are studied from the point of view of geographical environment, the available archaeological and ethnographic evidence, and from the point of view of agronomy and plant genetics. The regional emphasis varies from year to year. 1 unit. Prerequisite: Consent of instructor. C. S. ALEXANDER, STAFF.

436. Advanced Plant Physiology: Photosynthesis. Same as Botany 436. A lecture and laboratory course dealing with physiological, biochemical, and biophysical aspects of photosynthesis. 1 unit. Prerequisite: One year each of college biology, chemistry, and physics, or consent of instructor. GOVINDJEE, OGREN.

440. Design and Analysis of Biological Experiments. Same as Agricultural Engineering, Animal Science, Dairy Science, Food Science, Forestry, Horticulture, and Veterinary Medical Science 440. Statistical methods as tools for research. Principles of designing experiments and methods of analysis for various kinds of designs, including factorial experiments, are considered from the viewpoint of when and how to use them. ¾ unit. Prerequisite: Agronomy 340 or equivalent. CARMER, SEIF, WALKER.

441. Advanced Design and Analysis of Biological Experiments. Same as Agricultural Engineering 441. Design and analysis of complex experiments. Confounded factorials, lattice designs, and other incomplete-block experiments are considered from the viewpoint of their characteristics, methods of analysis, and usefulness in biological research. ½ unit. Prerequisite: Agronomy 440 or equivalent. CARMER.

442. Quantitative Aspects of Plant Breeding. A study of the theoretical bases for plant breeding procedures with special emphasis on the relationship between type and source of genetic variability, mode of reproduction, and effectiveness of different selection procedures. 1 unit. Prerequisite: Agronomy 323 or equivalent; Agronomy 441 or equivalent. DUDLEY.

493. Advanced Studies in Agronomy. Directed and supervised detailed study of selected problems or topics. ¼ to 2 units. Prerequisite: Consent of instructor. Study may be in any one of the following fields:

(a) **Soil Chemistry.**
(b) **Soil Fertility.**
(c) **Soil Physics.**
(d) **Soil Classification and Pedology.**
(e) **Soil Mineralogy.**
(f) **Soil Microbiology.**
(g) **Plant Breeding and Genetics.**
(h) **Plant Physiology.**
(i) **Weed Control.**
(j) **Crop Morphology.**
(k) **Crop Production and Ecology.**
(l) **Statistical Techniques and Data Processing.**

499. Thesis Research. 0 to 4 units.
(a) **Soils.** Aldrich, Beavers, Fehrenbacher, Gieseking, Hinesly, Jones, Klute, Kurtz, Melsted, R. Miller, Millington, Molina, Odell, Peters, Runge, Sabey, Stevenson, Tyner, Walker, Welch.
(b) **Crops.** Alexander, Bernard, Brown, Burger, Carmer, Cooper, DeWet, Dudley, Earley, Gerdemann, Hadley, Hageman, Hanson, Harlan, Hittle, Hooker, Jackobs, Knake, Lambert, Laughnan, Leng, Miller, Patterson, Pendleton, Rinne, Scott, Seif, Slife, Wax, Weber, Weibel, Widholm, Wilson, Woolley.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Advanced Special Problems. Individual problems in crops or soils. Graduate students majoring in agronomy do not receive graduate credit for this course. ½ to 2 units. Prerequisite: Consent of instructor. Staff.

301. Soil Survey with Emphasis on Illinois Soils. Properties and methods used in distinguishing soils; characteristics and distribution of different soils in Illinois and the cause of these soil differences; the influences of differences in Illinois soils upon their proper use and management. Laboratory work includes instruction in the use of soil maps, training in mapping soils, and field trips to examine representative soils. Field trips; estimated cost, $10.00. Credit is not given toward the Ph.D. for major or sole minor in Agronomy—Soils. ½ unit. Prerequisite: Agronomy 101. Odell.

303. Soil Fertility. Influence of chemical and microbiological properties of soils on crop production; rhizobial fixation and other fertility effects of crop sequence; fertilizer needs, sources, materials, and applications. Students taking this course do not receive credit for Agronomy 309 and 310. Credit is not given toward the Ph.D. for major or sole minor in Agronomy-Soils. ½ unit. Prerequisite: Agronomy 101. Welch.

304. Soil Management and Conservation. Influence of physical properties of soils on crop production; roles of drainage, tillage, crop sequence, and soil characteristics in land management. Students taking this course do not receive credit for Agronomy 309 and 310. Credit is not given toward the Ph.D. for major or sole minor in Agronomy-Soils. ½ unit. Prerequisite: Agronomy 101. Oschwald.

309. Intermediate Soil Science, I. Genesis, organic matter, microbiology, and mineralogy of soils. This course, if followed by Agronomy 310, is intended to provide a science-based treatment of the field of soil science. Credit is not given for Agronomy 309 in addition to Agronomy 303 and 304. 1 unit. Prerequisite: Agronomy 101; Botany 100; Chemistry 122 and 133; Microbiology 100 and 101; two 200- or 300-level courses in plant science; credit or registration in Physics 101. Melsted, Staff.

310. Intermediate Soil Science, II. Soil chemistry, fertility, physics, and soil-plant relationships. This course with Agronomy 309 is intended to provide an advanced treatment of the field of soil science. Credit is not given for Agronomy 310 in addition to Agronomy 303 and 304. 1 unit. Prerequisite: Agronomy 101; Botany 100 or 101; Chemistry 122 and 133; two 200- or 300-level courses in plant science; credit or registration in Physics 102 and Mathematics 132 or 133. KURTZ, MELSTED.

312. Farm Appraisals. Same as Agricultural Economics 312. Valuation methods and value bases of farm real estate. Includes legal aspects of appraisal work, appraisal theory and procedures, condemnation appraisal, characteristics of the farmland market, engineering and agronomic data for farm appraisals, and practice appraisals. Seven field trips; cost about $7.00. 1 unit. Prequisite: Agronomy 101 and Agricultural Economics 220, or equivalent. REISS.

313. Soil Mineral Analysis. Specialized analytical procedures for determinations of soil minerals and their properties; mineralogy of soils and relationships to soil genesis and fertility. 1 unit. Prerequisite: Agronomy 101 or consent of instructor. BEAVER, JONES.

321. Ecological and Physiological Factors Affecting Crop Production. The environmental requirements of crop plants and their physiological bases; the physical nature of the environment and its interaction with crop plants; and the distribution and yield of selected crops as a function of environment. 1 unit. Prerequisite: Botany 100 or 101; Chemistry 102 or 132 or 133. STAFF.

322. Forage Crops and Pastures. Roughage production, forage crop characteristics and ecology, grasslands of farm and range as related to animal production and soil conservation. Lectures and discussions. ½ unit. Prerequisite: Agronomy 121. D. A. MILLER.

323. Principles of Plant Breeding. Same as Horticulture 323. Genetic and cytological variation in crop plants, the production and control of such variation in developing varieties and hybrids, and the maintenance of high quality seed stocks. Field trips; estimated cost, $5.00. 1 unit. Prerequisite: Agronomy 110 or equivalent; Botany 100. HITTLE.

326. Weeds and Their Control. Weeds, their introduction, methods of dissemination, reproduction, and control; a characterization of the common weeds of the Midwest. ½ unit. Prerequisite: Agronomy 121. MCGLAMERY.

340. An Introduction to Applied Statistics. Same as Agricultural Engineering, Animal Science, Dairy Science, Food Science, Forestry, Horticulture, and Veterinary Medical Science 340. Statistical methods involving relationships between populations and samples; collection, organization, and analysis of data; techniques in testing hypotheses with an introduction to regression, correlation, and analyses of variance limited to the completely randomized design and the randomized complete-block design. ¾ unit. Prerequisite: Mathematics 104 or 111 or 112, or equivalent. SEIF.

350. Crops and Man. Interpretations of the role of crop plants in the development of cultures and civilizations. Crops are described primarily in terms of their origins, evolution, and influences on man's technology, art, and religion, and his social and political institutions. Field trip; estimated cost, $10.00. ¾ unit. HARLAN.

365. Digital Computer Methods for Statistical Data Processing. Same as Computer Science 365. A study of methods for efficient utilization of high-speed equipment in processing of statistical data. Emphasis is on principles of application of computing equipment to the solution of statistical problems. Numerous examples are given and actual problem solution by the student is accom-

plished. 1 unit. Prerequisite: Computer Science 101, 103, 107, or 121, and a course in statistics or statistical methods or equivalent, or consent of instructor. CARMER.

377. **Diseases of Field Crops.** Same as Plant Pathology 377. A study of the symptoms of the major field crop diseases, life histories of causal organisms, and methods of control. Offered in 1969-1970 and in alternate years. ¾ unit. Prerequisite: Plant Pathology 204 or equivalent. HOOKER.

ANIMAL SCIENCE

The Department of Animal Science offers graduate work leading to the Master of Science and Doctor of Philosophy in Animal Science. Research may be pursued in the following areas of specialization: (1) population and immunogenetics, (2) physiology of reproduction including endocrinology, (3) animal nutrition, (4) nutritional biochemistry, (5) ecology, and (6) meats technology. In addition, a student who expects to terminate the graduate program at the master's level may pursue work in animal production. Beef cattle, poultry, sheep, swine, and a wide variety of laboratory animals are available for use in conducting research in the above areas.

The minimum grade-point average for admission to graduate study in animal science is 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

Courses in biological and physical sciences and mathematics are essential preparation for graduate work in any specialized area of animal science. Candidates specializing in the areas of animal nutrition or nutritional biochemistry must have training equivalent to one five-hour course each in quantitative analysis and organic chemistry; a course in physical chemistry also is strongly recommended. Candidates specializing in meats technology should have undergraduate training in meat evaluation, use, and/or processing, and in microbiology. Students lacking adequate background to register in graduate courses at the University of Illinois are expected to remove course deficiencies during the first year of graduate study.

GRADUATE FACULTY

Professors: D. E. BECKER (Head of Department), O. G. BENTLEY, D. J. BRAY, H. H. DRAPER, P. J. DZIUK, R. M. FORBES, U. S. GARRIGUS, E. E. HATFIELD, A. H. JENSEN, J. KASTELIC, S. P. MISTRY, A. V. NALBANDOV, H. W. NORTON, B. A. RASMUSEN.

Associate Professors: B. G. HARMON, G. A. LEVEILLE.

Assistant Professors: W. W. ALBERT, D. H. BAKER, C. D. O. FOSTER, F. C. HINDS, D. E. JOHNSON, F. N. OWENS, J. R. ROMANS.

COURSES FOR GRADUATES

400. **Presentation of Experimental Results.** Preparation of technical material for oral or written presentation. ¼ unit. DZIUK.

401. **Topics in Ruminant Meat Animal Research.** A critical review and evaluation of certain aspects of ruminant nutrition and physiology with emphasis on techniques and procedures currently employed in research and the resultant application of research results to current as well as future meat animal production. 1 unit. Prerequisite: Consent of instructor. GARRIGUS.

402. **Principles of Sheep and Wool Production.** Basic considerations in sheep and wool production and lamb feeding. Reports of research. ½ unit. Prerequisite: Consent of instructor. GARRIGUS.

403. Techniques and Topics in Animal Research. Discussion and study of literature pertaining to animal research; application of experimental technics; special topics; review of research in current problem areas. ½ unit. Prerequisite: Consent of instructor.

404. Poultry Nutrition. A review of the current literature in nutrition and its applicability to the avian species. ½ unit. Prerequisite: Consent of instructor. BAKER.

405. Advanced Animal Genetics. Genetic theory, analysis of animal breeding problems, genetic results of selection, and different systems of breeding. 1 unit. Prerequisite: Animal Science 305 or equivalent. NORTON.

406. Physiology of Reproduction. Same as Zoology 406. Comparative physiology of reproduction and endocrinology of domestic and laboratory animals; fertility and sterility. Lectures and laboratory. 1 unit. NALBANDOV.

407. Laboratory Methods in Animal Genetics. ½ to 1 unit. Combined credit in Animal Science 407 and 408 may not exceed two units. Prerequisite: Consent of instructor. NORTON.

408. Laboratory Methods in Physiology of Reproduction. Same as Zoology 408. ½ to 1 unit. Combined credit in Animal Science 407 and 408 may not exceed two units. Prerequisite: Consent of instructor. NALBANDOV.

410. Research Methods in Animal Science. Intended to give students training and experience in various techniques used in research with poultry, sheep, swine, beef cattle, and meats. ¼ to 1 unit; may be repeated for credit not to exceed a total of one unit. Prerequisite: Consent of instructor. GARRIGUS, JENSEN, SCOTT, STAFF.

411. Population Genetics and Animal Breeding. Same as Dairy Science 411. The mathematical theory of population genetics and its application to the improvement of farm animals; results of different systems of mating and the expected gains from different methods of selection. 1 unit. Prerequisite: Animal Science 110 or equivalent. A knowledge of elementary algebra is essential. TOUCHBERRY.

412. Advanced Endocrinology. Same as Dairy Science, Physiology, and Zoology 412. Seminar, lectures, student reports, and discussions of recent advances in endocrinology. ½ unit; may be repeated for credit not to exceed a total of two units. Prerequisite: Consent of instructor. GORSKI, NALBANDOV.

420. Comparative Nutrition. Physiological aspects of the nutrition of higher animals and man, including the digestion, utilization, and function of nutrients, and the effects of dietary deficiencies. 1 unit. Prerequisite: Chemistry 350 and 355. FORBES, MISTRY.

421. Topics in Nutritional Biochemistry. Biochemical aspects of the nutrition of higher animals and man, with emphasis on the function and metabolism of nutrients. 1 unit. Prerequisite: Animal Science 420. DRAPER, MISTRY.

440. Design and Analysis of Biological Experiments. Same as Agricultural Engineering, Agronomy, Dairy Science, Food Science, Forestry, Horticulture, and Veterinary Medical Science 440. Statistical methods as tools for research. Principles of designing experiments and methods of analysis for various kinds of designs, including factorial experiments, are considered from the viewpoint of when and how to use them. ¾ unit. Prerequisite: Animal Science 340 or equivalent. SEIF.

463. Radioisotopes in Biological Research: Principles and Practice. See Veterinary Medical Science 463. ¾ unit. Prerequisite: Quantitative chemistry; one year each of mathematics, physics, biology, and/or consent of instructor. TWARDOCK.

481. Animal Biochemical Laboratory Techniques. Same as Dairy Science 481. Theory and application of biochemical laboratory techniques to research in the animal-oriented biological sciences. Isolation, characterization, and analysis of biological compounds including enzymes, metabolic intermediates, and cellular components; determination of metabolic pathways and processes. 1 unit. Prerequisite: Chemistry 350 and 355; consent of instructor. LARSON.

496. The Use of Carbon-14 in Labeling Techniques. Same as Chemistry 496. A comprehensive study of the chemistry of carbon-14. The laboratory work deals with vacuum-line manipulations and synthesis, degradation, and assay of radioactive carbon compounds. ¾ or 1 unit. Prerequisite: Chemistry 336, 337, and 338, or equivalent; consent of instructor. CONRAD, NYSTROM.

499. Thesis Research. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Beef Production. The principles of feeding and management of beef cattle; financial aspects of beef production; diseases, parasites, and breeding difficulties of beef cattle. Lectures, demonstrations, and discussions. ¾ unit. Prerequisite: Animal Science 221 or equivalent. HATFIELD.

302. Sheep Production. The sheep and wool industries; principles and practices of various phases of production. ¾ unit. Prerequisite: Animal Science 221 or equivalent. GARRIGUS.

303. Pork Production. The place of the swine enterprise on the farm; selecting, breeding, feeding, managing, and marketing of swine for greatest profit. ¾ unit. Prerequisite: Animal Science 221 or equivalent. HARMON, JENSEN.

304. Poultry Management. Application of scientific principles to the management of poultry. Undergraduate students may register for four hours credit with laboratory or for three hours credit without laboratory. ¾ unit. Prerequisite: Animal Science 221 or equivalent. BRAY.

305. Genetics and Animal Improvement. Same as Dairy Science 305. The principles of heredity and their application to the problems of animal improvement. ¾ unit; S, ½ unit. Prerequisite: Animal Science 110 or equivalent. RASMUSEN, TOUCHBERRY.

320. Nutrition and Digestive Physiology of Ruminants. Same as Dairy Science 320. The physiology and microbiology of digestion in the ruminant and biochemical pathways of utilization of the absorbed nutrients for productive purposes. ¾ unit. Prerequisite: Animal Science or Dairy Science 221. DAVIS, HINDS.

325. Principles of Animal Nutrition. Principles of animal nutrition and their application to veterinary practice. This course is designed primarily for students in veterinary medicine. 1¼ units; credit is not allowed for Animal Science 221 and 325. Prerequisite: Chemistry 354 or 350 and 355. DRAPER, OWENS.

330. Reproduction and Artificial Insemination of Farm Animals. Same as Dairy Science 330. The anatomy and physiology of reproduction in farm animals, the principles of artificial insemination, and the factors affecting conception in natural and artificial breeding. ¾ unit; S, ½ unit. Prerequisite: Zoology 104 and either Dairy Science 100 or Animal Science 100. GRAVES.

332. Livestock Marketing. Same as Agricultural Economics 332. Economic principles applied to marketing livestock and livestock products from the standpoint of producers, processors, and distributors; theoretical basis for evaluating alternative marketing systems and functions; evaluation of changes in the industry

affecting marketing decisions. Field trip; estimated cost, $10.00. ¾ or 1 unit. Prerequisite: Economics 108; Agricultural Economics 230 or an elementary marketing course. BROADBENT.

340. An Introduction to Applied Statistics. Same as Agricultural Engineering, Agronomy, Dairy Science, Food Science, Forestry, Horticulture, and Veterinary Medical Science 340. Statistical methods involving relationships between populations and samples; collection, organization, and analysis of data; techniques in testing hypotheses with an introduction to regression, correlation, and analyses of variance limited to the completely randomized design and the randomized complete-block design. ¾ unit. Prerequisite: Mathematics 104 or 111, or 112, or equivalent. SEIF.

346. Ethology. Same as Zoology 346. The behavior of animals as interpreted through comparative studies and experimentation. Lecture, ½ unit; lecture and laboratory, 1 unit. Prerequisite: One year of 300-level courses in zoology, physiology, or psychology; consent of instructor for laboratory enrollment. BANKS.

350. World Animal Agriculture. Same as Dairy Science 350. Survey and interpretations of the role of animal agriculture in various cultures of the world with particular references to underdeveloped countries of the world. The importance of improved animal agriculture for land resource utilization and for meeting food and animal power needs of people is discussed. ¾ unit. Prerequisite: Consent of instructor.

ANTHROPOLOGY

The Department of Anthropology offers graduate work leading to the Master of Arts and Doctor of Philosophy. Courses and guided study provide a broad coverage of anthropology with concentrations in ethnology of Latin America, aboriginal North America, Northern Eurasia, Japan, Indonesia, Southeast and South Asia, and Africa south of the Sahara; culture historical and archaeological methods; culture change and modernization in complex societies; urban anthropology; human ecology; structural and formal analysis of cultural systems; ethnolinguistics; and ethnomusicology. Relevant courses are offered in other fields, e.g., linguistics, history, sociology, geography, agricultural economics, life sciences, and preventive medicine. The department also supports student attendance at field schools and study in mathematics, languages, and other areas at summer institutes.

Original research in the field, laboratory, and library is financially supported by the department. Opportunities include participation in faculty research projects, attendance at University of Illinois archaeological and ethnological field schools held every summer, and independent graduate student research in the United States and abroad. For work on campus, the library and computer resources at the University of Illinois are outstanding.

Applicants for admission as first-year graduate students are required to have a grade-point average of 4.0 for the last sixty hours of undergraduate training. Exceptions may be made by a special committee for those applicants with a grade-point average between 3.5 and 4.0, particularly if the student displays substantial evidence of having acquired special skills or of having had significant experience relevant to anthropology. A student who does not have an undergraduate major in anthropology or its equivalent may be permitted to register for graduate courses, but will be required to make up any deficiencies.

A detailed statement of requirements for higher degrees and additional information about departmental programs and policies is available on request.

A graduate student must demonstrate ability to use, for scholarly purposes other than the exigencies of field investigations, either one foreign language at a

high level of proficiency or two at an ordinary level; the nature of the capacity to be tested and the language or languages will be chosen by the student's departmental advisory committee. The results of such tests will not be required to be shown on the student's official transcript; hence, the tests will be administered within the department or, in the case of a language which none of its faculty controls, by arrangements made by the department with qualified persons.

With the approval of the adviser and the department, a candidate may satisfy the minor requirement by taking courses within the department. Approval is given only in those cases in which a subfield, such as biological anthropology or anthropological linguistics, constitutes an essential part of the candidate's overall program.

GRADUATE FACULTY

Professors: E. M. Bruner (Head of Department), J. B. Casagrande, D. W. Lathrap, F. K. Lehman, O. Lewis, J. C. Mc.Gregor, B. Nettl, D. B. Shimkin.

Associate Professors: H. A. Gould, D. W. Plath, R. T. Zuidema.

Assistant Professors: C. M. Keller, A. H. Rohn, Jr., L. Rosen, J. F. Yegerlehner.

Instructor: C. J. Bareis.

COURSES FOR GRADUATES

401. **General Anthropology, I.** A comprehensive survey of the various subfields of anthropology, with special reference to contemporary trends in theory and method: anthropology among the sciences, historical perspectives, human evolution and variations, the nature of culture, cultural evolution, the ecological approach, archaeology, linguistics. 1 unit. Prerequisite: Twelve hours of anthropology or consent of instructor.

402. **General Anthropology, II.** Continuation of Anthropology 401. Cultural typology, technology and economic organization, social structure, political organization, religion, art, personality and culture, processes of culture change, acculturation, applied anthropology, the logic of anthropological research, field methods. 1 unit. Prerequisite: Anthropology 401 or consent of instructor.

409. **Field Methods in Linguistics.** Same as Linguistics 309. The recording and analysis of a spoken language with a native speaker of that language as an informant. ½ or 1 unit. Prerequisite: Linguistics 300 or 301, or consent of instructor. Lehman, Yegerlehner.

410. **Advanced Field Methods in Linguistics.** Same as Linguistics 310. Advanced analysis of a spoken language with a native speaker of that language as an informant. ½ or 1 unit. Prerequisite: Anthropology 309 or equivalent. Lehman, Yegerlehner.

429. **The Evolution of Agricultural Economies.** Same as Agronomy and Geography 429. The problems concerning the development of the several basic food crop economies are studied from the point of view of geographical environment, the available archaeological and ethnographic evidence, and from the point of view of agronomy and plant genetics. The regional emphasis varies from year to year. 1 unit. Prerequisite: Consent of instructor. Lathrap, Staff.

440. **Problems in Physical Anthropology.** A seminar designed to involve students in the theoretical and methodological approaches to problem areas in physical anthropology. 1 unit. May be repeated for additional credit. Prerequisite: Anthropology 340; consent of instructor.

450. Seminar in Anthropology. Analysis of selected topics of special interest in anthropology. 1 unit. Students may reregister in this course up to a total of two units. STAFF.

451. Social Structure. This course is intended to acquaint the student with the descriptive techniques and methods of structural and functional analysis currently employed by social anthropologists in the study of primitive social groups and their methods of operation. 1 unit. Prerequisite: Consent of instructor. STAFF.

452. Research Problems in Archaeology. Seminar oriented to current research problems in archaeology, designed to acquaint students with theoretical and methodological aspects of particular problems, and to develop a critical perspective of archaeological research. Course may be repeated for additional credit. 1 unit. Prerequisite: Consent of instructor. MC.GREGOR.

453. The Formal Analysis of Kinship Systems. A survey of a variety of the world's systems of kinship, marriage, and family organization. Concentration on the distinctive properties of kinship systems as a species of social structure, on the formal apparatus for describing and understanding them and their functions, and on the theory of kinship that arises from the use of such formal apparatus. ½ to 1 unit. Prerequisite: Consent of instructor. LEHMAN.

460. Theories and Methods in Anthropology. A seminar course identifying, investigating, and evaluating the various theories and trends, as well as methods employed by anthropologists. 1 unit. CASAGRANDE.

463. Seminar on Field Methods and Research Designs in Cultural Anthropology. Critical examination of field methods and research designs as reflected in selected studies covering the past seventy years, ranging from early missionary reports to those of contemporary field workers. An effort is made to discern major trends in methodology. Community studies and comparative studies on both the tribal and peasant levels are examined. 1 unit. Prerequisite: Consent of instructor. STAFF.

471. Personality, Culture, and Society. A seminar on selected topics in culture and personality. The emphasis varies from year to year; possible topics include the interrelationship between social systems and personality, national character studies, comparative education, cultural learning and transmission, the psychological concomitants of cultural change. 1 unit. Prerequisite: Consent of instructor. STAFF.

489. Readings in Anthropology. Individual guidance in intensive readings in the literature of one or more subdivisions of the field of anthropology, selected in consultation with the adviser in accordance with the needs and interest of the student. ½ or 1 unit. Prerequisite: One semester of graduate work in anthropology; consent of adviser. STAFF.

490. Individual Topics in Anthropology. Supervised individual investigation or study of a topic not covered by regular courses. The topic selected by the student and the proposed plan of study are approved by the adviser and the staff member who supervises the work. 1 to 4 units. Prerequisite: Consent of instructor. STAFF.

499. Thesis Research. Preparation of theses. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Introduction to Linguistics. Same as Linguistics 300. An introduction to the science of descriptive linguistics. ½ unit. Prerequisite: Fulfillment of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. STAFF.

307. Introduction to Mathematical Linguistics. Same as Linguistics 307. Principles of set theory, logic and formal systems, group theory, and automata theory; introduction to the formal theory of grammars. 1 unit. Prerequisite: Linguistics 300.

315. Area Studies in Ethnomusicology. Same as Music 317. A seminar devoted to intensive study in the music of one specific culture, e.g., Japan, China, Indonesia, India, the Near East, Africa, and New World Negro, European and American folk cultures, American Indian. ½ unit. Prerequisite: Senior standing in music or consent of instructor. NETTL.

316. Introduction to Music of the World's Cultures. Same as Music 316. An introduction to non-Western and folk music, to the role of music in the world's societies, and to the methods of collecting and studying music in non-literate, folk, and Asian high cultures. For students outside the School of Music. ½ unit. Prerequisite: Anthropology 103 or consent of instructor. NETTL.

317. Languages of the World. Same as Linguistics 317. A survey of the main language families of the world from both genetic and typological points of view, with special reference to the theory of syntactic descriptions. ½ unit or 1 unit. Prerequisite: Linguistics 300 or consent of instructor. YEGERLEHNER.

320. Political Anthropology. The comparative and analytic study of the political systems of representative non-Western peoples. Attention is also paid to the transformations of native political institutions as consequences of colonialism and political modernization. ½ or 1 unit. Prerequisite: Anthropology 103. STAFF.

321. Primitive Social Organization. Describes how pre-literate non-Western societies are organized. Introduces techniques and theories used to investigate social organization. Considers how social organization relates to the natural environment and other aspects of human activity, and briefly, the processes of social change. Designed to prepare students specializing in social anthropology for advanced courses and seminars and as a survey of the field for students going into other disciplines. 1 unit. Prerequisite: Anthropology 103, or 260, or 280, or equivalent.

330. Processes of Culture Change. The impact of modern cultures on native peoples, comparative study of the mechanisms underlying the transition to modernity in the new nations, and the psychological and structural aspects of acculturation and urbanization. ½ or 1 unit. Prerequisite: Anthropology 103 or consent of instructor. BRUNER.

331. Aboriginal North America. The course deals with three major topics: (1) the nature and structure of aboriginal North America as a cultural province and its ecological base; (2) distinctive and common features of American Indian cultures; (3) responses to the stresses of white contact. Selected type cultures and their adaptations to varying ecological situations are examined in detail. A student may not receive credit for both Anthropology 270 and 331. ½ or 1 unit. Prerequisite: Anthropology 260. SHIMKIN.

332. Native Cultures of South America. A survey of the nature and variability of the aboriginal Indian cultures of South America. Special emphasis is placed on the relationship between various typical cultures and their ecological setting. Sample cultures illustrating the full range of community stability, population density, and social complexity are studied. ½ or 1 unit. Prerequisite: Anthropology 260 or consent of instructor. ZUIDEMA.

333. Native Cultures of South America (Andean). A survey of Andean cultures at the time of the Spanish conquest, of their subsequent history and of modern Indian culture in the Andean countries. ½ or 1 unit. Prerequisite: Anthropology 260, 332, or consent of instructor.

340. **Human Evolution, I.** The principles of evolution, and a survey of the evolution of man and his progenitors to the Paleolithic. ½ or 1 unit. Prerequisite: Anthropology 240 or consent of instructor.

341. **Human Evolution, II.** The principles of human genetics, anthropological aspects of race and race formation, and hereditary and environmental factors in the biological variation of modern man. ½ or 1 unit. Prerequisite: Anthropology 240 or consent of instructor.

343. **Introduction to Primate Morphology and Behavior.** A survey of primate social behavior and the classification, morphology, and distribution of living and extinct species. Emphasis is placed on interrelationships with aspects of anthropological study. ½ or 1 unit. Prerequisite: Anthropology 340, or Zoology 101 or 104, or consent of instructor.

348. **The Prehistory of Africa.** The study of cultural development in Africa from the appearance of Hominids to the time of European domination. 1 unit. Prerequisite: Anthropology 220 or consent of instructor. KELLER.

349. **South American Culture History, I.** An examination of the factors influencing the initial peopling of South America, the spread and diversification of hunting and gathering economies, and the development and spread of the Tropical Forest cultural pattern. 1 unit. Prerequisite: Anthropology 220 or consent of instructor. LATHRAP.

350. **South American Culture History, II.** An examination of the factors leading to the rise of civilization in the Central Andes, including the evolution of agricultural systems, the elaboration of technology, and emergence of extensive and complex political units. 1 unit. Prerequisite: Anthropology 220 or consent of instructor. LATHRAP.

351. **Archaeological Surveying: Techniques and Applications.** Familiarization with methods used in the location and recording of archaeological sites, including techniques of mapping especially adapted to the needs of archaeology. Attention is also given to means of presenting results and interpreting data derived from this work. The course involves work both in the field and in the laboratory. 1 unit. Prerequisite: Anthropology 220 or equivalent, or consent of instructor. STAFF.

352. **Precolumbian Civilizations of Mesoamerica.** The major civilizations of Mexico and Guatemala are studied. Emphasis is placed on the growth and ramification of the several major cultural traditions and on the kinds of evidence which are available as a basis for the study of the growth of political units and their interaction. ½ or 1 unit. Prerequisite: Anthropology 220 or equivalent, or consent of instructor. LATHRAP.

353. **Southwestern Archaeology.** A detailed study of one archaeological unit in the United States, covering the three broad cultures with regional variations considered chronologically and stressing interrelationships of the various cultures. ½ or 1 unit. Prerequisite: Anthropology 220 or equivalent, or consent of instructor. MC.GREGOR, ROHN.

354. **Field Techniuqes in Archaeology.** Participation in archaeological excavation; techniques, methods, and procedures discussed and practiced in actual working conditions. S; 1 unit. Credit may be received twice if the areas or problems concerned are different. Prerequisite: Anthropology 102 and 103, or consent of instructor. STAFF.

355. **Laboratory Techniques and Problems in Archaeology.** Laboratory work in the field; studying, evaluating, and writing final reports on preceding field work. S; 1 unit. Credit may be received twice if the areas or problems concerned are

different. Prerequisite: Anthropology 102 and 103, or consent of instructor. STAFF.

356. Physical Anthropology. The aims and methods of physical anthropology, both osteology and somatology, with emphasis on the human skeleton. 1 unit. Prerequisite: Anthropology 102 and 103, or, with consent of instructor, a course in anatomy or comparative anatomy, physiology, or introductory zoology. MC.GREGOR.

357. Midwestern Prehistory. A detailed study of the midwestern archaeological area covering the broad cultures with regional variations considered chronologically and stressing their interrelationships. ½ or 1 unit. Prerequisite: Anthropology 220 or equivalent, or consent of instructor. MC.GREGOR.

358. Prehistory of the Old World. An examination of Old World prehistory showing developments and relationships between various cultural traditions and histories from the earliest times. ½ or 1 unit. Prerequisite: Anthropology 220 or consent of instructor. KELLER.

359. The Mesolithic and the Origins of Food Production in the Old World. Continuation of Anthropology 358. Designed to give students an introduction to the postglacial hunting communities of Europe from around 8000 B.C. to the origins of food production, and to the domestication of animals in Europe, the Near East, and the Mediterranean basin. 1 unit. Prerequisite: Anthropology 220; consent of instructor.

360. Peoples of Oceania. A survey of the groups inhabiting the islands of the Pacific, including Australia. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor. ROSS.

361. Peoples and Cultures of Mexico and Guatemala. A survey of the people and cultures of Middle America with special emphasis upon Mexico and Guatemala. This course begins by placing Middle America geographically, historically, and culturally within the broader Latin-American scene. The countries are first viewed as a whole and then selected ethnographic studies of specific communities are considered for comparative purposes. The Caribbean is not studied. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor. BUTTERWORTH.

362. Patterns of Folk and Peasant Cultures. An analysis of the development of folk and peasant cultures in various parts of the world. Data are drawn from archaeological and historical records as well as from contemporary ethnological studies. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor.

363. Religion in Primitive Society. An introduction to the study of magic and religion in nonliterate societies. The course considers theories of the origin and function of magic and religion and an analysis of magic and religion in representative primitive societies. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor. ROSS.

364. Field Work in Cultural Anthropology. Supervised participation in field research. Technique and procedures are discussed and practiced under actual working conditions. S; 1 unit. Credit may be received twice if the areas or problems involved are different. Prerequisite: Anthropology 102 and 103; speaking knowledge of the language of the area concerned; registration in Anthropology 365; consent of instructor. STAFF.

365. Analysis of Field Data in Cultural Anthropology. Evaluation, organization, and write-up of field data. S; 1 unit. Credit may be received twice if the areas or problems involved are different. Prerequisite: Anthropology 102 and 103;

speaking knowledge of the language of the area concerned; consent of instructor. STAFF.

366. **Peoples of Southeast Asia and Indonesia.** The culture, history, economy, social system, political organization, and character structure of the peoples of Indonesia, Malaya, and the Philippines. Attention also is paid to contemporary economic and political problems of the newly independent nations seen from an anthropological perspective. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor. LEHMAN.

367. **Peoples and Cultures of Africa.** A survey of the cultures of Africa with particular emphasis on the ecological and historical development of culture types and the behavior associated with them. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor. STAFF.

368. **Peoples and Cultures of India.** A description and analysis of the social, economic, and religious life of the tribal and peasant peoples of contemporary India, considered against the background of Indian geography, population, language distribution, the caste system, and highlights of Indian cultural development. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor. GOULD.

369. **Introduction to Human Ecology.** Same as Geography, Health Education, Physiology, Psychology, Sociology, Veterinary Medical Science, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations, and physiological, psychological, and sociological adjustments to environment, regulation of population, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology; one year of anthropology, geography, geology, or sociology. SHIMKIN, STAFF.

370. **Language, Culture, and Society.** Same as Communications and Linguistics 370. An examination of the social and cultural functions of language, with particular emphasis on the application of linguistic methods and findings to selected problems in the social sciences. ½ or 1 unit. BRUKMAN.

371. **Culture and Personality.** A cross-cultural comparative analysis and evaluation of current theories of culture and personality formation. The course is concerned with the socio-cultural matrix in which personality develops, as well as with the application of personality concepts, especially those derived from psychoanalytic theory, to the study of primitive and modern society, ½ or 1 unit. Prerequisite: An introductory course in anthropology, sociology, or psychology, or consent of instructor. BRUNER.

372. **The Anthropological Study of Art.** A review of the anthropological approach to art with emphasis on structural analysis and the relationship of the artist to his culture. Problems of stylistic development are considered within the framework of cultural dynamics, and a survey of the major art style areas outside the Western tradition and the Orient is included. ½ or 1 unit. Prerequisite: Three hours of anthropology or consent of instructor. LATHRAP.

373. **Human Development in Cross-Cultural Perspective.** Same as Psychology 373. The comparative analysis of recurrent problems inherent in the biosocial nature of man, particularly as these are reflected in stages of the life cycle from birth through death. Attention is also given to the cross-cultural study of other selected topics such as illness and health, deviancy, and the handling of aggression. Use is made of materials available on the campus in the Human Relations Area Files. ½ or 1 unit. Prerequisite: Six hours of anthropology, sociology, or psychology, or consent of instructor.

374. Problems in Human Ecology. Same as Geography, Health Education, Physiology, Psychology, Sociology, and Veterinary Medical Science 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multidisciplinary studies of selected current problems. 1 unit. Prerequisite: Anthropology, Geography, Health Education, Physiology, Sociology, or Zoology 369. STAFF.

375. Peoples and Cultures of the Near and Middle East. A general survey of the bionomy of the area, followed by a description and analysis of the cultural patterns and social systems of the major ethnolinguistic divisions—Semitic, Iranian, Turkic—and the interrelating function of Islam. Particular consideration given to language, folklore, belles-lettres, music, architecture, crafts, etc., from an anthropological standpoint. Thereafter, selected ethnographies are considered for comparative purposes. ½ or 1 unit. Prerequisite: Anthropology 102 and 103, or consent of instructor. ROSEN.

377. Regional Topics in African Anthropology. Covers select sociocultural and historical topics of a separate region of Africa (e.g., East, West, Central, South, or North Africa) each time course is taught. Research paper. May be taken a second time only when different region is emphasized. 1 unit. Prerequisite: Consent of instructor. STAFF.

380. Applied Anthropology. The contributions of anthropology to modern problems such as the direction and execution of technical assistance programs in nonindustrialized areas of the world, and other cross-cultural contacts involving problems of administration, economic development, and the introduction of new practices and techniques. Designed to be of particular value to those students who expect to carry on technical or professional work among peoples of different cultures in foreign areas or in the United States. ½ or 1 unit. Prerequisite: Six hours of anthropology or sociology, or consent of instructor.

381. Russian Culture History and Ethnology. Same as Geography 381. An historical and structural analysis of the development of Russian culture, especially the peasant traditions, from Danubian to contemporary times. ½ or 1 unit. SHIMKIN.

382. Siberian Culture History and Ethnology. Same as Geography 382. An ecological analysis of historic and present-day Siberian cultures, with comparisons to Arctic America. ½ or 1 unit. SHIMKIN.

383. Cultures of Modern East Asia. Human life in the cultural setting of East Asia since the early nineteenth century. This course centers upon problems of adapting traditions and institutions to the needs of modern industrial civilization; geographical focus varies. 1 unit. Prerequisite: An introductory course in anthropology or East Asian history, or consent of instructor. PLATH.

385. The Anthropology of Education. Same as History and Philosophy of Education 385. Introduction to the contribution of anthropology to the cross-cultural study of education; includes illustrative material from representative cultures ranging from primitive social groups to present-day national states; emphasis is on education as a cultural process in relation to culture change and cultural development. ½ to 1 unit. Prerequisite: A course in anthropology or sociology, or consent of instructor.

ARCHITECTURE

(Including Architectural Engineering)

The Department of Architecture offers graduate work leading to the Master of Architecture and Master of Science in Architectural Engineering. Fields of speciali-

zation are architectural and urban design (problems in advanced design, analytical studies of selected building types, or investigation of design factors and principles); advanced structural theory and design; architectural administration and building construction; history of architecture.

The prerequisite for graduate study in architecture is a bachelor's degree in architecture equivalent in scope and standards to that of the University of Illinois. The minimum grade-point average for admission to graduate study in architecture is 3.75. Applicants with averages below 3.75 but above 3.5 are considered on an individual basis. Applications from students expecting to register for courses in architectural or urban design must be accompanied by samples of their work in these areas.

Students are expected to follow one of the recommended area programs unless approval is obtained from the chairman of the department for a special program. A minimum of eight units is required for the master's degree.

GRADUATE FACULTY

Professors: J. H. Swing (Chairman of Department), J. S. Baker, L. J. Brightbill, G. T. Clayton, E. A. Connally, P. H. Coy, W. L. Creese, W. Eng, G. Guevrekian, H. L. Hornbeak, R. A. Jones, A. K. Laing, W. H. Lewis, R. P. Link, C. B. Looker, A. Notaras, W. J. O'Connell, J. G. Replinger, I. Schousboe, R. J. Smith, S. J. Y. Tang, A. R. Williams, C. A. Winkelhake, H. C. Young.

Associate Professors: V. V. Cafourek, G. Exline, E. M. Farnham, R. D. Katz, S. T. Lanford, C. T. Marfort, F. D. Moyer.

Assistant Professors: G. Francescato, L. A. Leffers, J. E. Simon.

COURSES FOR GRADUATES

431. Advanced Theory of Architecture. A review of principles of architecture and urban design; factors in programming architectural requirements; design development; analysis and criticism. ½ unit. Prerequisite: Consent of instructor. Williams.

432. Seminar in Architectural Design. The analysis and criticism of selected buildings. Individual reports and discussion. ½ unit. Prerequisite: Architecture 431 or consent of instructor. Williams.

435. Advanced Architectural Design. Advanced study of space relationships and other elements of architectural design from urban scale to that of individual buildings, including the integration of structural, mechanical, and interior design. Joint studies in urban design with graduate students in urban planning and landscape architecture. 2 units. Prerequisite: Bachelor's degree in architecture (general option) or consent of instructor. Williams, Staff.

452. Advanced Theory and Design of Steel Structures. Theory and design in bending, buckling, torsion, and combined stresses in beams and columns. Study in design and behavior of connections; composite constructions; light gauge steel construction analysis. Design and economy of simple and complex building frames. 1 unit. Prerequisite: Architecture 348 or consent of instructor. Tang, Staff.

454. Advanced Structural Design in Reinforced Concrete. Critical review of the methods and specifications involved in the design and behavior for flexure, shear, bond, and anchorage; slab-beam-girder, ribbed joist, two-way and flat-slab floor construction; columns and footings; torsion; plastic theory of design; economy and continuity in building design. 1 unit. Prerequisite: Architecture 358 or consent of instructor. Tang, Staff.

456. Matrix Methods of Structural Analysis. Use of matrix mathematics and digital computers in the analysis of indeterminate structures by the displacement and force methods. 1 unit. Prerequisite: Computer Science 101, Architecture 347; or consent of instructor. TANG, STAFF.

481. Architectural Practice and the Construction Industry. Analysis of the construction industry and identification of those factors adversely affecting its development. Characteristics of, and relationships among, such components as architectural and engineering services, labor, contractors, manufacturers, building economics, governmental agencies, and research and testing agencies. Experts from these fields are invited to lead discussions on current problems and their solutions, on procedures adversely affecting the industry, and on current and needed areas of research. ½ unit. Prerequisite: Consent of instructor. LEWIS.

491. Special Problems in Architectural Administration and Building Construction. Individual or group research on approved subjects. ½ to 2 units. Prerequisite: Credit or registration in Architecture 481. LEWIS.

493. Special Problems in Structural Theory and Design. Individual or group investigation and study in architectural engineering application. Research in economy and design in correlation with architectural, mechanical, and structural requirements. Options: foundation design; prestressed concrete design; plastic design in steel; structural planning; wood construction; architectural research laboratory. ½ to 4 units. Prerequisite: Consent of instructor. TANG, STAFF.

494. Special Problems in Architectural Design. Individual or group investigation of building types, aesthetic problems, and other aspects of architecture. ½ to 2 units. Prerequisite: Architecture 435 or consent of instructor. WILLIAMS, VISITING CRITICS.

496. Special Problems in Architectural History. Individual investigation of the work of particular architects, specific buildings, or the architecture of periods or regions; comparative studies; aesthetic problems. ½ to 2 units. Prerequisite: Twelve hours of architectural history or consent of instructor. LAING, STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Independent Studies in Urban Design. The individual study of selected topics involving the history, design, and function of significant European cities. ¾ unit. Prerequisite: One year of history of architecture or history of art; consent of instructor.

310. Ancient Classical Architecture. The development of architecture and urban design in the ancient Greek world and the Roman Empire. ¾ unit. Prerequisite: Architecture 211 and 212, or Art 111 and 112, or consent of instructor.

311. Early Medieval Architecture. The architecture and urban design of the Byzantine Empire, Slavic states, Islam, and Western Europe from the early Christian to the Gothic era. ¾ unit. Prerequisite: Architecture 211 and 212, or Art 111 and 112, or consent of instructor.

312. Gothic Architecture. The development of architecture and urban design in Europe from the end of the Romanesque period to the Renaissance. ¾ unit. Prerequisite: Architecture 211 and 212, or Art 111 and 112, or consent of instructor.

313. Italian Renaissance and Baroque Architecture. The development of architecture, urban design, and garden art in Italy from the early fifteenth century to the late eighteenth century. ¾ unit. Prerequisite: Architecture 211 and 212, or Art 111 and 112, or consent of instructor.

314. French Architecture, 1500 to 1800. The development of architecture, urban design, and landscape architecture in France from the early sixteenth century to the late eighteenth century; French influence in the rest of Europe. ¾ unit. Prerequisite: Architecture 211 and 212, or Art 111 and 112, or consent of instructor.

315. English and American Architecture. Major architectural developments in Great Britain in the sixteenth, seventeenth, and eighteenth centuries; regional building traditions; sources and development of colonial architecture in America. ¾ unit. Prerequisite: Architecture 211 and 212, or Art 111 and 112, or consent of instructor.

316. Architecture of the Nineteenth and Twentieth Centuries. The development of architecture and urban design in Europe and the Americas from 1800 to the present, with special consideration given to the influence of technology and urban conditions. ¾ unit. Prerequisite: Architecture 211 and 212, or Art 111 and 112, or consent of instructor.

317. The Development of Contemporary Architectural Thought. An examination of the philosophy of significant architectural writers and architects in relation to their projects and executed work. Those studied include Wright, Gropius, Le Corbusier, Mies van der Rohe, Ruskin, Pugin, Blondel, Laugier, Lodoli, Palladio, Alberti, and Vitruvius. ¾ unit. Prerequisite: Architecture 211 and 212, or Art 111 and 112, and consent of instructor.

337. Architectural Design. Continued study of architectural design emphasizing (a) complex site development and composition, and (b) definitive design and refinement of detail for one of the plan components. Preparation of senior thesis program. 2 units. Prerequisite: Architecture 236.

338. Architectural Design. Individual research and comprehensive design solution of a selected architectural project, with special emphasis on site development, integration of structures; mechanical equipment, illumination, and acoustics. 2 units. Prerequisite: Architecture 337.

344. Design Development and Construction Documents. Continued design development and integration of architectural, structural, mechanical, and electrical work for a previously designed student project; application of building codes, production planning, and preparation of general construction working drawings and specifications. No graduate credit. Prerequisite: Architecture 242 and 257; registration in Architecture 337 for general option students, or consent of instructor.

347. Theory of Structures. Advanced problems in the analysis of statically determinate structures; general theories and methods of analysis of statically indeterminate structures; relationships between analysis and design of building frames. 1½ units. Prerequisite: Architecture 257; Mathematics 142.

348. Advanced Structures. Advanced topics on design of structural members and connection. Analysis and design of continuous structures, rigid frames, and tall buildings. 1½ units. Prerequisite: Architecture 347; credit or registration in Architecture 358.

358. Advanced Reinforced Concrete. Reinforced concrete building design. 1 unit. Prerequisite: Architecture 247; credit or registration in Architecture 348.

379. Urban Housing. A study of housing needs, comparative means of financing, comparative building types and costs, and contemporary examples of public and private housing in Europe and the United States. ½ unit. Prerequisite: Consent of instructor.

ART

The Department of Art offers graduate work leading to the degrees listed below.

For admission, an applicant must be a graduate of an accredited college or university with at least a bachelor's degree and with a grade-point average of 3.5 or above; he must be accepted by the graduate committee of the Department of Art after examination of his transcripts, as well as examples of his work if his major is to be in a creative field. Students expecting to major in art education must have (or be eligible for) a teaching certificate in their field. Applicants are expected to have completed an undergraduate program similar to that which leads to the bachelor's degree as established at this University, with a major, or related studies acceptable to the advisers, in the field to be pursued in graduate study.

The minimum residence period is two years for the Master of Fine Arts and one year for the Master of Arts. However, duties relating to graduate assistantships and thesis requirements (in art history) will correspondingly extend the period of residence. When pertinent, the graduate committee may extend the residence or increase the unit or course requirements.

Complete descriptions of offerings and admission requirements for all degrees, and instructions for applying for admission and grants may be had by writing for application forms and the brochure, *Graduate Programs in Art,* to Warren F. Doolittle, Chairman of Graduate Programs in Art, Department of Art, 140 Fine and Applied Arts Building.

Master of Fine Arts with Design Major (Graphic Design or Industrial Design). Students must complete all the following courses for a minimum of sixteen units: Art 491, one to three units; Art 493, one unit; Art 467 or 477, six to ten units; art history (selected from the group Art 301 through 328), three-fourths unit to one and one-half units; electives or interdisciplinary subjects as determined in consultation with the adviser, two to six units. A thesis is required.

Master of Fine Arts with Painting and Printmaking Major. Students must complete all the following courses for a minimum of sixteen units: Art 491, one to three units; Art 493, one unit; Art 495, two to eight units; Art 497, two to eight units, one unit of which must be in intaglio; art history (two courses selected from the group Art 301 through 328), one and one-half units; electives (Art 332, 341, 351, 392, 393, 394, 491, 494; art history and/or other courses approved by the adviser), two to six units. A thesis exhibition is required.

Master of Fine Arts with Sculpture Major. Students must complete all the following courses for a minimum of sixteen units: Art 491, one to three units; Art 493, one unit; Art 496, six to ten units; art history (two courses selected from the group Art 301 through 328), one and one-half units; electives (Art 332, 333, 341, 383, 392, 393, 394, 491, 494; art history and/or academic courses approved by the adviser), two to six units. A thesis is required.

Master of Arts with Art Education Major. Students must complete all the following courses for a minimum of eight units: Art 493, one unit; art history (one course selected from the group Art 301 through 328), three-fourths unit; art electives, two and one-fourth units; Educational Psychology 311, one-half unit; Educational Psychology 312, one-half unit; Secondary and Continuing Education 456, one unit; two of the following: History and Philosophy of Education 301, 302, 303, 304, one unit; electives, one unit. No thesis is required. See pages 38 and 39.

Master of Arts with Art History Major. Students must complete all the following courses for a minimum of eight units: Art 493, one unit; Art 494, one

unit; art history and architectural history (Art 301-328, 450-454, Architecture 310-317), three units minimum; Art 499 (thesis), one-half to one unit; electives (art history, architectural history, or related fields approved by the adviser), one to three units. Courses are offered in six areas: ancient, medieval, Renaissance, baroque, modern, and oriental. Students must have at least two courses in each of four of these areas, and at least one course in each of the other two. (Courses taken in undergraduate years may be counted toward fulfillment of this requirement, but will not reduce the total number of units needed for the degree.) An examination taken soon after arrival will point out strengths and weaknesses of individual students and aid in working out their total program. A qualifying examination, normally taken at the end of the program, must demonstrate that the student has a general knowledge of the whole field of art history. Proficiency in German or French must also be demonstrated. A thesis is required.

Doctor of Education in Art Education. The program leading to the Doctor of Education with a major in art education is designed to provide advanced professional preparation for art educators and to develop educational leaders with a high level of art and educational competence. The program is offered jointly by the Department of Art and the College of Education.

Admission. A candidate for admission must hold a master's degree in fine arts, or art education, or the equivalent from an accredited institution. He must also have a minimum of two years' acceptable teaching experience. Admission is determined by examinations administered by the Department of Art and the College of Education, personal interviews, record of previous education and experience, and recommendations from persons who have known the candidate. Examinations administered by the Department of Art include art education, art history, and art processes. Portfolios of art work may also be required.

Applicants for admission should present credentials well in advance of their first registration. Planning a program of study requires that examinations and other steps preliminary to admission be completed prior to the registration period. Admission is not complete until the candidate is accepted by two joint advisers, one from the Department of Art and one from the College of Education.

Residence. Minimum residence requirement is one year of uninterrupted work during which a minimum of six units of work is successfully completed. The remaining course work may be completed during summer sessions or during the regular school year.

Program. A minimum of sixteen units of course work beyond the requirements for the master's degree is required, including six units of credit in art and art education and six units of credit in education. The following courses are required: Elementary Education 455, one unit; History and Philosophy of Education 405 and 410, two units; Educational Psychology 390 and 415, two units; Art 493, one unit; a course in research in art education, one unit; electives in art and art education, three units; electives in education, two units; electives, four units.

A thesis is required, but no academic credit is granted for the thesis. General regulations of the Graduate College covering the filing of the thesis title and the preparation, submission, and publication of the thesis must be met.

Doctor of Philosophy in Art History. This program is designed to prepare students for significant, original research and for creative scholarship and teaching on the college level. The history of architecture is an integral part of the curriculum.

Applicants must have a master's degree in the history of art or the equivalent. They must also achieve a high score on the qualifying examination required for the master's degree and be recommended by the graduate committee in the history of art and the history of architecture. In accordance with the requirements of the Graduate College and subject to such special additional examinations as the graduate committee in history of art and architecture may prescribe, applicants may

petition to apply toward the doctor's degree credit for graduate work received at institutions other than the University of Illinois.

All requirements of the Graduate College must be fulfilled in addition to the special stipulations of the program in history of art.

With the approval of the adviser, the student normally elects to write the dissertation and to specialize in one of the areas in history of art which follow: ancient, medieval, Renaissance, baroque, modern, or oriental.

In addition to the field of specialization, the student selects either one or two approved minors. The single minor, or one of the two if two are chosen, must be in a subject other than the history of art or the history of architecture. Among such approved subjects are anthropology, classics, history, linguistics, literature (English or other), musicology, philosophy, psychology, sociology, speech, and theatre. The first of two minors may be in an area of the history of art.

In addition to credit for the dissertation, a minimum of four units of graduate study (including work for the master's degree) is required in the field of specialization. At least four units of study are required for a single minor. A minimum of three units is required for the first of two minors, two for the second.

A preliminary examination, part written, part oral, is given covering three fields in history of art and the minor in a cognate field. The final examination is oral and consists primarily of the student's defense of the conclusions reached in the dissertation.

An effective reading knowledge of both French and German, as tested primarily by procedures outlined by the Graduate College, is required for those who specialize in a phase of western art. Chinese or Japanese will be substituted for one of these languages by those who specialize in the arts of the Far East. The substitution of high proficiency in one language for proficient reading ability in two is not acceptable in history of art. These language requirements must be fully met before the student has earned four units of graduate credit beyond the requirements for the master's degree. In many instances, a working knowledge of a third foreign language will be necessary.

Applicants should fill out a "Graduate Application for Admission or Readmission" and the "Application for Graduate Appointment," if pertinent, and return with transcripts and other supplementary material to W. F. Doolittle, Chairman, 140 Fine and Applied Arts Building, University of Illinois, Champaign, Illinois. No examples of creative work are required.

The Department of Art's brochure, *Graduate Programs in Art,* which deals primarily with master programs in art but contains some information pertinent to Ph.D. applicants, will be sent upon request, as will an application kit.

Although admissions applications are processed throughout the year, applications for grants are only considered in the February 15th screening which precedes expected June or September admission.

If the applicant wishes to correspond directly with the adviser of the program, he should write Edwin Rae, 118 Architecture Building, if his major is to be in art history, or Professor Alan Laing, 103 Architecture Building, if the major is to be in architectural history.

GRADUATE FACULTY

Professors: J. R. Shipley (Head of Department), E. H. Betts, C. W. Briggs, W. F. Doolittle, D. E. Frith, F. Gallo, J. W. Kennedy, K. M. Lansing, R. Perlman, E. C. Rae, J. Schueler, H. A. Schultz, M. A. Sprague, R. W. Sterkel, R. A. von Neumann, A. S. Weller, E. C. Wicks, E. J. Zagorski, N. Ziroli.

Associate Professors: P. Bodnar, N. McFarland, Ann Perkins, J. A. Savage, A. R. Sinsabaugh.

Assistant Professors: M. Franciscono, K. Munakata, Minerva Pinnell, D. M. Rowan.

COURSES FOR GRADUATES

450. Studies in Modern Art. Investigation of special problems; writings of artists and critics; preparation of critical reports. 1 unit. Prerequisite: Consent of instructor.

451. Studies in American Art. Investigation of special problems; historical development of the study of American art; techniques of conservation and restoration. 1 unit. Prerequisite: Consent of instructor.

452. Seminar in Chinese Art. Investigation of selected phases, concepts, and problems of the art of China; intensive reading and reports. 1 unit. Prerequisite: Art 328 or consent of instructor.

453. Seminar in Japanese Art. Investigation of selected phases, concepts, and problems of the art of Japan; intensive reading and reports. 1 unit. Prerequisite: Art 327 or consent of instructor.

454. Seminar in Ancient Art. Research seminar in problems selected from the art of ancient Mediterranean area. 1 unit. Prerequisite: At least one of the following: Art 304, 305, 306, 307, or equivalent.

467. Graphic Design Laboratory. Individually directed research in problems of visual design with emphasis on the understanding of recent developments in nonverbal communication and the utilization of contemporary graphic processes. 1 to 3 units. Prerequisite: Bachelor of Arts or Bachelor of Fine Arts in visual communications or related equivalent.

477. Industrial Design Laboratory. Individually directed research in the drafting room or workshop with concentration in industrial design. 1 to 3 units. Prerequisite: Bachelor of Fine Arts in industrial design or equivalent.

491. Special Problems. Individual direction in research and in creative activity; thesis. ½ to 2 units.

492. Individual Readings in History of Art. Directed readings in special fields or aspects of history of art not provided in depth by the current course offerings. ½ to 1 unit. Prerequisite: Consent of instructor.

493. Seminar: Introduction to Methods and Criticism. 1 unit. Prerequisite: Graduate standing in art.

494. Seminar: Studies in the Development of Art History and Criticism. The relation of art history and criticism; changing standards and criteria; intensive reading of selected critical works; the writing of art criticism. 1 unit. Prerequisite: Consent of instructor.

495. Painting Laboratory. Professional and experimental painting with emphasis on the development of maturity of style and personal expression. ½ to 3 units.

496. Sculpture Laboratory. Experience at a professional level in sculptural techniques including metals casting, welding, stone carving, wood carving, clay modeling, and ceramic sculpture, with emphasis on the development of creative achievement. 1 to 3 units. Prerequisite: Graduate standing in art and permission of the departmental graduate committee.

497. Print Workshop. Intaglio, relief, and planographic; printing, including etching, engraving, aquatint, wood, paper and plastic relief printing, and lithography. ½ to 3 units.

499. Thesis Research. Guidance in research and writing theses for advanced degrees. 0 to 4 units. Prerequisite: Graduate standing in history of art.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Greek Painting. Vase paintings, wall paintings, mosaics, and other examples of the graphic art of the Greek world from Mycenaen times through the Hellenistic period. ¾ unit. Prerequisite: Art 306 or consent of instructor.

302. Art of the Ancient Near East. Focuses on Egypt and Mesopotamia and deals to a lesser degree with the more peripheral or eclectic arts of Persia, Syria-Palestine, and Anatolia. The period extends from the late prehistoric age to the time of Alexander the Great. ¾ unit. Prerequisite: Art 306 or consent of instructor.

303. Art of the Eastern and Western Roman Empire. Deals with monuments outside Italy both in the eastern and western parts of the Empire. The influence of native traditions and the development of local styles is emphasized. ¾ unit. Prerequisite: Art 307 or consent of instructor.

304. Greek Sculpture. A survey of the development of Greek sculpture from Mycenean times to the Christian era with analysis of the major works in relief and in the round. ¾ unit. Prerequisite: Art 306 or consent of instructor.

305. Art of the Augustan Age. A study of the major works of architecture, sculpture, and painting in Italy and the Roman Empire from the time of Augustus. ¾ unit. Prerequisite: Art 307 or consent of instructor.

306. Near Eastern and Greek Art. Architecture, sculpture, and painting of Egypt, Western Asia, Crete, and of Greece from Mycenean times through the Classical period. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

307. Hellenistic, Roman, and Byzantine Art. Architecture, sculpture, painting, and mosaics of the Hellenistic world, Italy and the Roman empire, and the Byzantine empire. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

308. Early Medieval Art. The arts of Byzantium and of Western Europe from the early Christian through the Romanesque period. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

309. Gothic Art. The arts of Western Europe from the end of the Romanesque period until the Renaissance. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

310. The History of Printmaking. The development of the various graphic processes in the hands of important printmakers from the fifteenth through the nineteenth centuries. ½ or ¾ unit. Prerequisite: One year of history of art or consent of instructor.

313. Italian Renaissance Art. Architecture, painting, sculpture, and minor arts of Italy during the Renaissance. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

314. Northern Renaissance Art. Architecture, painting, sculpture, and minor arts of France, Germany, Spain, and England in the sixteenth, seventeenth, and eighteenth centuries. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

315. Art of the Nineteenth Century. Architecture, painting, sculpture, and minor arts of the nineteenth century in France, Germany, Spain, and England. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

316. Later Chinese Painting. A study in depth of later phases of Chinese painting, particularly that of the Ming and Ch'ing dynasties; connoisseurship in Chinese

painting. ¾ unit. Prerequisite: Art 328, or a course in Chinese history of the period covered, or consent of instructor.

318. Latin-American Art. Study of the more important phases and periods of the visual arts of Latin America. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

319. Italian Art of the Seventeenth and Eighteenth Centuries. An examination of the arts of painting, sculpture, and architecture of the seventeenth and eighteenth centuries in Italy in terms of major figures and dominant stylistic tendencies. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

320. Northern European Art of the Seventeenth and Eighteenth Centuries. An examination of major developments in painting, sculpture, and architecture in the Low Countries, France, Spain, and England during the seventeenth and eighteenth centuries, in terms of major figures and dominant stylistic developments. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

321. Twentieth-Century Art, 1900 to 1925. Study of the leading personalities and movements in Western painting, sculpture, and architecture, with emphasis on the first. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

322. Twentieth-Century Art, 1925 to Date. Study of the leading personalities and movements in Western painting, sculpture, and architecture, with emphasis on the first. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

323. American Art to 1840. Architecture, painting, sculpture, and minor arts of the Colonies and the United States to 1840. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

324. American Art, 1840 to 1900. Architecture, painting, sculpture, and minor arts of the United States. ¾ unit. Prerequisite: One year of history of art or consent of instructor.

325. Recent American Painting and Sculpture. Current developments, with special emphasis on works shown in contemporary exhibitions at the Krannert Art Museum. ½ or ¾ unit. Prerequisite: One year of history of art or consent of instructor.

326. Art of Medieval Japan. A study of Japanese art, primarily painting, from the thirteenth century, with emphasis on the work of individual artists. ¾ unit. Prerequisite: Art 327, or a course in Japanese history of the period covered, or consent of instructor.

327. Japanese Art. History of Japanese art from earliest times to the twentieth century. ¾ unit. Prerequisite: One year of history of art or junior standing.

328. Chinese Art. History of Chinese art from earliest times to the present. ¾ unit. Prerequisite: One year of history of art or junior standing.

338. Cinematography. Theory and practice of motion pictures as an art form. Emphasis is on individual creative production. ½ to 1 unit; may be repeated to a maximum of 2 units. Prerequisite: Art 215; consent of instructor.

380. Drawing. Advanced drawing in several media. ½ to 1 unit. Prerequisite: Art 126 or equivalent; for graduate students, consent of departmental graduate committee.

381. Painting. Advanced painting in oil and other media. Not open to candidates for the Master of Fine Arts in painting and printmaking. ½ to 1 unit; may be

repeated for a total of 2 units. Prerequisite: Art 142 or equivalent; for graduate students, consent of departmental graduate committee.

382. Painting Materials and Techniques. Study of the materials and techniques used in the various media: oil, watercolor, tempera, gouache, encaustic, etc. ½ unit. Prerequisite: Art 142 or graduate standing in art.

383. Print Media. Advanced work in various printmaking techniques. Not open to candidates for the Master of Fine Arts in painting. ½ to 1 unit. Prerequisite: Art 284 or equivalent; for graduate students, consent of departmental graduate committee.

385. Lithography. Laboratory course in lithography. Course of study includes a complete development of the process, exploiting its potential as a fine art medium. ½ to 1 unit. Prerequisite: Art 286; for graduate students, consent of departmental graduate committee.

387. Photography. Emphasis on development of mature creative attitudes through use of personal images and interpretations. Work in black and white, and color. ½ or 1 unit; may be repeated for a total of 2 units. Prerequisite: Art 216 or equivalent; consent of instructor.

391. Advanced Sculpture Techniques. Advanced work in various sculptural media. ½ to 1 unit. Prerequisite: Art 252 or equivalent.

392. Silversmithing, I. Advanced course in design and execution of hollowware, dealing primarily with raising and spinning methods and with the decorative processes of chasing, repoussé, niello, filigree, and inlay. ½ to 1 unit. Prerequisite: Consent of instructor.

393. Silversmithing, II. Advanced course in design and execution of flatware and hollowware, dealing primarily with forging and seaming methods, engraving, and toolmaking. ½ to 1 unit. Prerequisite: Consent of instructor.

394. Ceramic Design. Ceramic design with emphasis on the development of professional style and personal expression. ½ to 2 units. Prerequisite: Art 295 or consent of instructor.

ASIAN STUDIES

(Including Burmese, Chinese, Indonesian, and Japanese)

A graduate minor in Asian studies is administered by the Center for Asian Studies in cooperation with various departments. It is possible for a graduate student electing this minor to concentrate on East Asia, Southeast Asia, South Asia, or the Near and Middle East, or a combination of two or more of these areas.

A candidate for a master's degree who elects Asian studies as a minor must earn at least two units of graduate credit in at least two departments from approved courses.

A doctoral candidate who elects Asian studies as a minor must earn at least four units of graduate credit in at least two departments from approved courses.

The courses chosen for the graduate minor must be in departments outside the candidate's major. The list of the courses which may be chosen to satisfy the minor in Asian studies is available at the Center for Asian Studies, 1208 West California Avenue, Urbana.

Also, the doctoral candidate must, prior to the completion of his course requirements for the degree, complete satisfactorily one of the following: Arabic 304, Burmese 304, Chinese 304, Hindi 304, Indonesian 304, Japanese 304, or equivalent.

Candidates should contact the Director of the Center for Asian Studies regarding additional courses which would be acceptable.

Students who do not elect an Asian studies minor but who seek knowledge of Asian affairs, cultures, and languages are invited to consult, either directly or through their advisers, with the Director of the Center or with faculty associated with the Center in order to develop programs suited to their individual needs.

The adviser for the graduate minor is Professor Robert B. Crawford, Director of the Center for Asian Studies, 1208 West California Avenue, Urbana.

GRADUATE FACULTY

Professor: G. L. Tikku.

Associate Professor: Yamuna Kachru.

Assistant Professors: Y. Iwamoto, S. Makino.

Burmese

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. Intermediate Burmese, I. Introduction to a wider variety of styles and contexts of discourse and usage; written Burmese and an orderly view of Burmese grammar. ½ unit. Prerequisite: Burmese 202 or equivalent. Lehman.

304. Intermediate Burmese, II. Concentration upon ability to engage in active and reasonably fluent discourse in Burmese, on the grammar of sentence formation and ability to read ordinary Burmese texts. ½ unit. Prerequisite: Burmese 303 or equivalent. Lehman.

Chinese

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. Intermediate Chinese, I. First term of second year of work in Chinese language, with drill for more advanced conversational fluency; introduction to a greater variety of styles and levels of discourse and usage, increasing study of the written language, and more formal grammar. ½ unit. Prerequisite: Chinese 202 or equivalent. Chang.

304. Intermediate Chinese, II. Concentration upon ability to engage in fluent discourse in Chinese, on comprehensive grammatical knowledge, and on ability to read any ordinary simple text in Chinese. ½ unit. Prerequisite: Chinese 303 or equivalent. Chang.

305. Advanced Chinese, I. Reading and translation of graded selections from modern Chinese literary and journalistic writing. ½ unit. Prerequisite: Chinese 304 or equivalent. Chang.

306. Advanced Chinese, II. Reading in modern Chinese literary and journalistic writings; introduction to classical Chinese to prepare students of modern Chinese to understand classical forms and quotations occuring in vernacular text and to use dictionaries and reference works. ½ unit. Prerequisite: Chinese 305 or equivalent. Chang.

307. Introduction to Literary Chinese. An introduction to literary language, style, and structural patterns as reflected in the Confucial Classics and other literary, philosophical, and historical texts. 1 unit. Prerequisite: Chinese 306.

308. Readings in Literary Chinese. Readings in texts selected from the Confucian Classics and other literary, philosophical, and historical texts. Attention is given to linguistic and intellectual patterns and problems of translation. ½ or 1 unit.

309. Social Science Readings in Chinese. Reading and translation of selected Chinese texts in the social sciences with emphasis on specialized terminology and prose style. ½ or 1 unit. Prerequisite: Chinese 306.

310. Modern Chinese Literature. Reading and analysis of selected works of Chinese literature since the May 4th movement with special attention to the relationship between literature and ideology in twentieth-century China. 1 unit. Prerequisite: Chinese 306.

Indonesian

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. Intermediate Indonesian, I. First term of second year of work in the Indonesian language, with drill for more advanced conversational fluency; introduction to a greater variety of styles and levels of discourse and usage, increasing study of the written language, and more formal grammar. ½ unit. Prerequisite: Indonesian 202 or equivalent. YERGERLEHNER.

304. Intermediate Indonesian, II. Concentration upon ability to engage in reasonably fluent discourse in Indonesian, on comprehensive knowledge of grammar, and on ability to read ordinary written Indonesian. ½ unit. Prerequisite: Indonesian 303 or equivalent. YERGERLEHNER.

Japanese

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. Intermediate Japanese, I. First term of second year of work in the Japanese language, with drill for increased conversational fluency; introduction to a greater variety of styles and levels of discourse and usage, increasing study of the written language, and more formal grammar. ½ unit. Prerequisite: Japanese 202 or equivalent. MAKINO.

304. Intermediate Japanese, II. Concentration upon ability to engage in reasonably fluent discourse in Japanese, on comprehensive view of formal grammar, and on ability to read simple written Japanese. ½ unit. Prerequisite: Japanese 303 or equivalent. MAKINO.

305. Advanced Japanese, I. Course for advanced knowledge of Japanese with emphasis on reading. ½ unit. Prerequisite: Japanese 304 or equivalent. MAKINO.

306. Advanced Japanese, II. Course for advanced knowledge of Japanese with emphasis on reading. ½ unit. Prerequisite: Japanese 305 or equivalent. MAKINO.

309. Social Science Readings in Japanese. Readings in Japanese social science materials, including articles from newspapers, periodicals, and learned journals. ½ or 1 unit. Prerequisite: Japanese 306.

310. Modern Japanese Literature. Readings and analysis of selected Japanese texts, primarily fiction. ½ to 1 unit. Prerequisite: Japanese 306.

ASTRONOMY

The Department of Astronomy offers graduate work leading to the Master of Science and Doctor of Philosophy in Astronomy (including radio astronomy). Admission requires a minimum grade-point average of 4.0. Applications of students

with grade-point averages below 4.0 but above 3.75 are considered on an individual basis. In addition, the normal entrance requirements are as follows: (1) a bachelor's degree in astronomy, physics, electrical engineering, or mathematics, and (2) a one-year course in descriptive astronomy.

The eight units for the Master of Science may be obtained in three ways, listed as (1), (2), and (3) below. Alternative (3) is intended for students wishing to specialize in radio astronomy.

(1) All eight units may be taken in astronomy; at least three units must be at the 400 level.

(2) Two units may be selected from approved courses in mathematics; two units may be taken in approved courses in physics; the remaining units must be taken in astronomy. At least three units must be at the 400 level, and at least two of these three units must be taken in astronomy.

(3) Five units may be earned by taking Physics 341, 342, Electrical Engineering 420, 421, and Astronomy 357. The remaining three units must be taken in astronomy; only one of these units need be at the 400 level.

Details regarding the Doctor of Philosophy may be obtained by writing to the Head of the Department, University of Illinois Observatory.

For information regarding applied mathematics, see page 307.

GRADUATE FACULTY

Professors: G. C. McVittie (Head of Department), G. W. Swenson, Jr., S. P. Wyatt, K. M. Yoss.

Associate Professors: J. H. Cahn, J. R. Dickel, J. B. Kaler, E. C. Olson.

COURSES FOR GRADUATES

401. Stellar Atmospheres. Physical characteristics of stellar atmospheres as derived from spectroscopic observations; radiation transfer, theory and observations of the continuous spectrum, limb darkening; formation of absorption lines, line profiles, curves of growth, relative chemical abundances; emission features; forbidden radiation. 1 unit. Prerequisite: Consent of instructor. Kaler.

403. Gaseous Nebulae and the Interstellar Medium. Distribution, structure, and spectra of nebulae; physical processes in planetary and diffuse nebulae; recombination, fluorescence, and forbidden line radiation; determination of physical parameters; nature of the interstellar medium; interstellar gas and grains; observation of interstellar medium. 1 unit. Prerequisite: Astronomy 301. Kaler.

404. Theory of Stellar Structure. Masses, luminosities, radii, and surface temperatures of stars; basic equations and stability conditions; nuclear reactions; integration of basic equations; results—initial stages, later stages, white dwarfs. 1 unit. Prerequisite: Consent of instructor. Olson.

415. Experimental Methods in Radio Astronomy. Design and construction of instruments for radio astronomy; techniques of observation of celestial radio sources; interpretation of data. 1 unit; may be taken a second time for credit. Prerequisite: Consent of instructor. Dickel, Swenson.

424. Relativity and Cosmology. Same as Mathematics 460 and Physics 424. Elements of tensor calculus and Riemannian geometry; special relativity; Lorentz transformations, equivalence of mass and energy; general relativity and the gravitational field of the sun; galaxies and cosmology. 1 unit. Prerequisite: Consent of instructor. McVittie.

433. Solar System Astrophysics. Planetary orbits and perturbations; physical perturbations; physical parameters of the planets; planetary interiors, atmospheres,

magnetospheres, and surface layers; the satellites; asteroids and comets; meteors, meteorites, and tektites; interplanetary grains and gas; problems of origin and evolution. 1 unit. Prerequisite: Consent of instructor. DICKEL, WYATT.

486. Constitution of the Ionosphere: An Introduction to Aeronomy. Same as Electrical Engineering 486. Properties of the neutral and ionized atmosphere above 60 km. height, and the photochemical processes causing them; diffusion of ionospheric constituents; solar and meteoric peturbations of the ionosphere. 1 unit. Prerequisite: Graduate standing in electrical engineering, physics, or astronomy; Mathematics 341 or equivalent. BOWHILL.

491. Seminar in Special Topics. 1 to 4 units. Prerequisite: Consent of instructor. STAFF.

499. Thesis Research. 0 to 3 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Introductory Astrophysics. Stars, observational data and their determination; atoms and radiation; stellar atmospheres; equilibrium of stellar interiors; special types of stars, interstellar matter. 1 unit. Prerequisite: Physics 108. OLSON.

302. Astrophysics of the Sun. Observations of the sun at all wavelengths and application of the results to the study of the photosphere, chromosphere, and corona; structure of the atmosphere of the quiet sun; solar activity. 1 unit. Prerequisite: Astronomy 301. DICKEL.

306. Foundations of Mechanics and Gravitational Theory. Same as Aeronautical and Astronautical Engineering 306. Introduction to the dynamics of particles and rigid bodies with special emphasis on elementary planetary motion, motion of a rocket, motion of long-range projectile relative to Earth, precession of Earth's axis, etc. 1 unit. Prerequisite: Mathematics 142 or 143. AVNER.

307. Celestial Mechanics. Two-body problem; Kepler's equation; planet's orbit in space; distance in solar system; gravitational potential; perturbations in planetary motion; dynamical theory of stars of high velocity; spiral arm of galaxy. 1 unit. Prerequisite: Astronomy 306 or Physics 322. AVNER.

314. Observational Astronomy. Same as Civil Engineering 305. Astronomical coordinate systems and transformations; theory of, and practice in, approximate and precise determinations of latitude, longitude, and time; introduction to theory of errors; theory and practice of astronomical photography. 1 unit. Prerequisite: Astronomy 102 or 210, or Civil Engineering 201; Mathematics 142 or 143. WYATT.

315. Observational Techniques and Reductions. Methods of observation and reductions in photographic and photoelectric photometry, spectrophotometry, and stellar radial velocity determinations. 1 unit. Prerequisite: Astronomy 314. Yoss.

317. Elements of Magnetohydrodynamics. Same as Aeronautical and Astronautical Engineering 317. Equations of magnetohydrodynamics, single-fluid and multiple-fluid models, magnetic interaction parameters, magnetosonic waves, hydromagnetic shock waves, aligned-field and crossed-field flows, theory of characteristics, MHD acceleration, generation, and propulsion. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 213 or consent of instructor. BOND.

321. Stellar Systems, I. Galactic structure: the observational data; stars in the solar neighborhood; the solar motion; stellar statistics and distribution; stellar

populations; interstellar matter and spiral structure; the whole galaxy. 1 unit. Prerequisite: Astronomy 102 or 210; Physics 108. Yoss.

322. Stellar Systems, II. Continuation of Astronomy 321. Galactic dynamics: stellar motions; galactic rotation; dynamics and mass distribution; stellar encounters; dynamics of interstellar matter. Galaxies: distances, structural features; groups and clusters; radio galaxies and quasars; spatial distribution and motions. 1 unit. Prerequisite: Astronomy 321. WYATT.

357. Radio Astronomy. Same as Electrical Engineering 357. Instrumental theory and observational technique; radar and meteors; the moon and planets; solar radio waves; galactic and extragalactic radio astronomy. 1 unit. Prerequisite: Physics 108. DICKEL.

366. Aeronomy: Physics of the Upper Atmosphere and Space. Same as Electrical Engineering and Physics 366. Structure and composition of the Earth's upper atmosphere, solar radiation and its interaction with the upper atmosphere; the ionospheric layers; planetary atmospheres; airglow and aurora; interplanetary plasma; the magnetic field of the Earth and its interaction with the solar plasma; experimental techniques. 1 unit. Prerequisite: Physics 321, 342, and 381; or consent of instructor. RAETHER.

BIOCHEMISTRY

Biochemistry is a multidisciplinary field resulting from the interactions of chemistry and physics with biology. Biochemistry staff offer training in biochemistry, and also in molecular biology and biophysical chemistry (see below and also pages 119 and 125). Programs leading to graduate degrees in biochemistry are offered in the Biochemistry Division of the Department of Chemistry and Chemical Engineering. Entering graduate students in biochemistry must therefore meet the graduate entrance requirements of that department (see page 118).

Interested students should contact the Biochemistry Division.

BIOLOGY

See descriptions and course listings under Life Sciences, page 269.

BIOPHYSICS AND BIOPHYSICAL CHEMISTRY (MOLECULAR BIOLOGY)

Biophysics is a rapidly growing field that cuts across many disciplines. An area overlapping with this and developing through interaction of chemistry and biology is that of biophysical chemistry.

Since graduate study in biophysics and biophysical chemistry involves several areas of biological and physical sciences, the Graduate College has adopted a flexible system enabling students to enter special interdisciplinary programs in these areas, thus affording them a wide range of opportunity for study and research in borderlands between the biological and physical sciences.

For the program leading to the Doctor of Philosophy in Biophysics, see descriptions and course listings under Life Sciences, pages 281 and 285.

Students majoring in chemistry or microbiology may elect to specialize in biological problems at the molecular level (see pages 119 and 277). Students in other areas of the biological and physical sciences who wish to arrange programs of study emphasizing biophysics should direct their inquiries to the head of the major department.

BOTANY

See descriptions and course listings under Life Sciences, page 271.

BUSINESS

The Doctor of Philosophy in Business is awarded to those who complete the subject matter requirements listed below and the general requirements outlined in the first section of this catalog. The subject matter requirements represent primarily a carefully selected group of subjects offered in the several fields of the College of Commerce and Business Administration.

Candidates for the degree should have a training such as that represented by graduation from an accredited college of commerce or school of business. Students who have not graduated from such college or school or from an institution offering an equivalent program must present a minimum of thirty hours in commerce subjects, including at least one course in each of the following: accountancy, economics, management, and marketing. Those candidates who hold a master's degree in economics or business can usually complete the requirements in two years by synchronization of courses previously taken with those offered in this program.

In lieu of the usual major and minor requirements for the doctorate, candidates for the Doctor of Philosophy in Business must prepare themselves for examination in five fields. Two of these, management and economic theory, are required, but the other three are elective. One of the elective fields may be outside the College of Commerce and Business Administration and must include at least two units. Within these requirements, it is expected that each student will select, in consultation with his adviser, an individual program of study to meet his specific needs and objectives. For numbers and titles of courses available, see the listings in this catalog under accountancy, economics, finance, and business administration.

Because the major fields for this degree cross departmental lines, administration of the work is supervised by a committee. A doctor's dissertation constitutes the work of the third graduate year. Correspondence relating to the degree should be addressed to the Chairman of the Committee on the Doctor of Philosophy Degree in Business, 360 Commerce and Business Administration Building (West).

COURSES FOR GRADUATES

499. Thesis Research. 0 to 4 units.

BUSINESS ADMINISTRATION

(Including Industrial Administration and Marketing)

The Department of Business Administration offers programs leading to degrees in Business Administration, Management, and Marketing.

BUSINESS ADMINISTRATION

The Department offers professional programs in business administration leading to the degrees of Master of Business Administration, Doctor of Business Administration, and Master of Commerce.

Master of Business Administration. The Master of Business Administration program is designed primarily for students whose undergraduate preparation is in liberal arts and sciences, engineering, or other nonbusiness areas. Students whose

undergraduate preparation is in business may apply for admission, and the make-up of programs of those admitted is frequently adjusted to account for the special preparation of the degree candidate. The M.B.A. program requires a minimum of sixteen units (or sixty-four semester hours) of course work. No thesis is required. Candidates are admitted in September and February.

Doctor of Business Administration. Applications for the Doctor of Business Administration program should have completed their master's program in the upper one-half of their master's class. A minimum of eight units of professional courses beyond the master's degree is required. Candidates who have earned a master's degree from one-year programs are required to complete a minimum of sixteen units of course work. Candidates are admitted in September, February, and June.

Master of Commerce. The Master of Commerce program is designed specifically for students whose undergraduate preparation is in business. Candidates for the Master of Commerce degree are required to take an evaluation examination upon entering the program. This examination covers the equivalent of the first-year M.B.A. program. An outstanding performance on this examination permits granting of the Master of Commerce degree after completion of eight units of course work. Normally, a candidate who is well prepared in the several areas of business administration is required to complete twelve to fourteen units of work.

Acceptance in any of the above professional programs requires a grade-point average of at least 3.5 on a 5.0 scale, in the last sixty hours of undergraduate work and an acceptable score on the Admissions Test for Graduate Study in Business.

INDUSTRIAL ADMINISTRATION (MANAGEMENT)

The Department offers graduate work either as a major or a minor leading to the Master of Science in Management, and as a minor for the Doctor of Philosophy.

Admission requires a grade-point average of 4.0 for the last sixty hours of undergraduate study. Candidates with a grade-point average from 3.75 to 4.0 may be considered on an individual basis. Such students may be required to take an appropriate examination such as the Admission Test for Graduate Study in Business (fee, $10.00).

To do major work in the field of management, a student must have completed at least twenty hours of undergraduate work in business administration and related subjects. To do minor work in this field, at least twelve hours of work in business administration and related subjects are required.

MARKETING

Graduate work may be taken in the field of marketing for a major or a minor for the Master of Science and for the Doctor of Philosophy. To do major work in this field, a student must have a grade-point average of at least 4.0 and adequate undergraduate training in business and marketing, quantitative analysis, and the social sciences. The program of each student, including the selection of an appropriate minor, must be approved by the graduate adviser or head of the department.

ALL PROGRAMS

Additional information concerning the requirements of the various degree programs may be obtained from the Department of Business Administration, 350 Commerce and Business Administration Building (West).

GRADUATE FACULTY

Professors: R. N. Corley, P. M. Dauten, Jr., R. Ferber, R. M. Hill, F. M. Jones, J. A. Litterer, J. W. McGuire, P. C. Roberts.

Associate Professors: R. L. Black, D. R. Day, H. Hinomoto, B. F. Kirkpatrick, R. D. Millican, L. J. Rago, J. L. Simon, S. Sudman.

Assistant Professors: J. B. Cohen, D. M. Gardner, K. M. Rowland, W. D. Seitz.

Business Administration

COURSES FOR GRADUATES

474. **Operations Research.** A study of quantitative techniques useful in economic analysis and decision making. Mathematical programming, dynamic programming, queueing theory, renewal theory, and simulation methods are applied to economic control systems with special emphasis on the problems of the firm. Offered in 1969-1970 and in alternate years. 1 unit. Prerequisite: Mathematics 863 and Business Administration 374 or equivalent. Shupp.

500. **Business Economics.** Analysis of supply and demand functions in an uncertain environment; practical applications of economics to the management of business enterprise; the firm's place in the economic system; the place of the enterprise in national accounts. Case materials are used. ¾ unit. Prerequisite: Enrollment in a graduate program.

501. **Managerial Economics.** Monetary and national income analyses essential to understanding governmental policies directed to macro-economic goals; the impact of such policies on the individual business firm and on decision-making by business management; the responsibilities of the individual business firms in contributing to the attainment of social goals of a macro-economic nature; the role of the business leader in formulating public policy in the macro-economic area. ¾ unit. Prerequisite: Business Administration 500 or equivalent.

510. **Administrative Behavior.** This course focuses on the problems faced by an administrator in an interpersonal setting. Primary emphasis is on the analysis of individual and group behavior in a union and nonunion work setting and the determination of actions which the administrator can take to promote desired work performance. Extensive use is made of theory and research related to individual and group behavior to aid in the diagnosis of problems covered. Students take part in either laboratory or field studies. ¾ unit. Prerequisite: Enrollment in a graduate program.

511. **Business Organization.** An analysis of business organization. Major emphasis is on the processes of allocation, coordination, and communication, making decisions about organizations under conditions of certainty and uncertainty for optimal performance, and measures of organizational performance. Critical examination of factors involved in choosing either a centralized or a decentralized style of organization. ¾ unit. Prerequisite: Business Administration 510.

512. **Business Organization and Its Environment.** An analysis of business organizations adapting to shifts in internal and external elements. Major emphasis is on (1) the business firm as a part of a complex socio-economic system; (2) the effects of government, labor unions, and political, religious, and business organizations on the executive's decision problems; (3) environmental factors conducive to organizational change; and (4) organizational growth. ¾ unit. Prerequisite: Business Administration 511.

513. **Seminar in Organization Theory.** This course examines the major types of organization theory. Use of organization theory to guide research and to make business decisions; examination of major research methods used to study business organizations. ¾ unit. Prerequisite: Business Administration 512.

520. Marketing. An introductory analysis of the marketing system, its operations, and the mechanisms for coordinating these operations. The relationships of the firm to other firms and other institutions in the marketing system are studied, and the effects that such relationships have on the nature of decision problems of the individual business are analyzed. The firm's problem in developing an integrated marketing program, and the specific problem areas of price, channel, location, sales, and market development are discussed. ¾ unit. Prerequisite: Enrollment in a graduate program.

522. Quantitative Analysis for Marketing Decisions. The development of analytic quantitative models of various aspects of the firm's marketing environment and of models of marketing decision problems is studied. The course also involves a study of the ways in which such models can be used as a basis for making marketing decisions. Topics include market measurement, estimation of various kinds of market data, identification of the relationships between marketing variables, and forecasting. ¾ unit. Prerequisite: Business Administration 520 or equivalent.

524. Market Development. Communication from manufacturers and middlemen to consumer and industrial users, and from manufacturers to middlemen, is an essential element in the marketing process. The course deals with management of the several components of the market communication function including personal selling, advertising, sales promotion, and some marketing aspects of public relations activities for both consumer and industrial goods. Management of the market communication function is studied through cases dealing with (1) determining market communications goals and policies; (2) creating an organization to perform the market communication function; (3) planning market communication operations, including problems such as planning a sales campaign, selecting advertising media, setting standards and coordinating advertising with personal selling, and dealer promotions; (4) stimulating personnel and controlling execution of the plans; and (5) evaluating results obtained from specific selling activities. ¾ unit. Prerequisite: Business Administration 522 or equivalent.

525. Product Management. This course deals with the decisions on the firm's total market offer, including such topics as (1) use of market analysis in making decisions on assortment, product development, pricing, packaging, branding, and sales forecasting, and (2) coordination of these decisions and actions with market communications, physical movement, production, finance, and the over-all goals and policies of the firm. The use of analytic and research methods in making assortment and product decisions is emphasized. ¾ unit. Prerequisite: Business Administration 522 or equivalent.

527. Seminar in Marketing Theory and Policy. This seminar is designed to study theories relating to the marketing system and the role of the individual business firm within that system. Marketing policy problems are discussed within the framework of various aspects of the firm's environmental circumstances. Marketing planning and decision-making processes covered include those involved in choice of policy concerning the marketing mix, price and product strategy, market development, and social and governmental relations. ¾ unit. Prerequisite: Business Administration 524 or 525.

531. Introduction to Production. An introductory course in decision-making problems in production. The course includes the theoretical foundations for production management as well as the applications of decision-making techniques to production problems in the firm. In particular, production processes, plant layout, maintenance, scheduling, quality control, and production control are considered. ¾ unit. Prerequisite: First semester of the M.B.A. program.

532. Production Planning and Control. Decision-making topics in production at the factory manager level and above are treated in depth. Topics include the development of generalized decision rules and systems analysis in production. In particular, the design of production control, quality control, and inventory control systems are stressed, and each of these systems is integrated into the firms as a whole. ¾ unit. Prerequisite: First year of the M.B.A. program.

533. Quantitative Techniques in Production. An advanced course in the application of quantitative techniques to decision-making problems dealing with production in the firm. Topics include structural estimation of production systems, application of operations research techniques to production problems, and computer simulation of decision systems. ¾ unit. Prerequisite: Business Administration 532 or equivalent.

540. Written Analysis, I. To develop the student's ability in writing reports based upon analysis of cases and the conclusions reached, this course has a threefold objective: (1) to improve the student's capacity to express himself effectively and efficiently in writing; (2) to contribute to the sharpening of his analytic skills; and (3) to help him integrate the knowledge learned in the functional fields. ½ unit. Prerequisite: Enrollment in a graduate program.

541. Written Analysis, II. The first part of this course is devoted to the scientific method of inquiry and specific research techniques. The purpose is to study both elements of basic logic and research procedures in order to help the student evaluate the reliability of data and validity of conclusions contained in business reports. The second part of the course is devoted to a major field study. Each student develops a solution to a business problem and presents an oral and written report of the solution to both the faculty and the businessmen concerned. ½ unit. Prerequisite: Business Administration 540 or equivalent.

542. Business and Society. The position of the business enterprise as an institution in American society; the role of the businessman in that society. ¾ unit. Prerequisite: Completion of the first year of the M.B.A. program or equivalent.

543. Legal Problems of Business Management. Past and current development of the legal climate in which business operates and in which managerial decisions are made; growth of the common law with its system of courts and procedure for law enforcement; the law of contracts, including various devices available for protection of creditors; legal problems involved in selecting a form of business organization. Students analyze business problems to see the importance of proper applications of the law to managerial decisions in regard to business policies. ¾ unit. Prerequisite: Completion of the first year of the M.B.A. program or equivalent.

544. Executive Policies and Planning. A course on policy construction at the executive level and the planning aspects of policy implementation. Builds a general management point of view. Study of company-wide situations from the vantage point of the chief executive. Case method study with supporting readings. Develops integration and application of the subject matter of prior courses. 1 unit. Prerequisite: Completion of the first year of the M.B.A. program or equivalent.

545. Business Logistics. Movement, distribution, and control of raw materials and finished goods; site selection for manufacturing, warehousing, and distribution facilities; transportation media, selection, inventory control, communications networks, and requirements for logistics control data. Emphasis is on developing an integrated logistics system for a company. ¾ unit. Prerequisite: Enrollment in second year of the M.B.A. program or consent of instructor.

551. Financial Analysis. An introduction to the subject of managerial finance, with emphasis on basic decisions of management and provision of capital resources.

Techniques of profit planning and forecasting, evaluation of financial performance relative to control standards, and development of criteria for commitment of funds are stressed. ¾ unit. Prerequisite: First semester of the M.B.A. program.

552. **Financial Management and Control, I.** An analysis of the tools and techniques of capital expenditure management, with emphasis on the relation of financial forecasting and control to criteria for investment planning and asset management. The theory of investment is examined, as well as the relation of organizational structure to capital planning policy. ¾ unit. Prerequisite: Business Administration 551.

553. **Financial Management and Control, II.** An analysis of the problems confronting corporate financial management in deciding appropriate methods of financing capital expenditure commitments. A thorough analysis of the specialized literature, coupled with the use of selected case material, forms the core of the course. ¾ unit. Prerequisite: Business Administration 552.

554. **Financial Theory and Policy.** Special problems of economic analysis and their relation to the functional discipline of managerial finance; includes study of techniques for forecasting financial requirements under uncertainty, problems of income determination, the relation of long-term capital commitments to uncertain payoff vectors, internal and external capital rationing, and problems of identifying capital supply functions. ¾ unit. Prerequisite: Business Administration 553, 573, and 576.

555. **Risk Management and Control.** Same as Finance 470. An analysis of the risk management problem in the business enterprise with emphasis on methodology for risk analyses, techniques for risk and loss control, models for risk management decision-making, and procedures for administering risk management policy relating to non-speculative (insurable) risk. 1 unit. Prerequisite: Business Administration 552 and 560, their equivalents, or consent of instructor.

557. **Seminar in Finance.** Analysis of (1) financial policies and problems connected with corporate expansion through acquisition of interest in, or absorption of, established concerns including an examination of the legal, economic, and financial background for business combination, or (2) specific problems of financial management in light of differing operating characteristics of major enterprise classifications, including opportunities for students to construct decision models for application to problems of financial management. ¾ unit. Prerequisite: Business Administration 554 and 573.

560. **Managerial Accounting and Control.** An analysis of managerial controls, the information needed for their operation, and the manner in which accounting provides that information; emphasis upon accounting as a tool of management. Problems and cases stress the type of figure information relevant to managerial decisions, and the methods of using such data. ¾ unit. Prerequisite: Enrollment in a graduate program.

562. **Industrial Cost Control.** A study of cost accounting, with emphasis on the use of operating data by management for control purposes. Methods of material pricing, labor costs, including fringe benefits; indirect manufacturing costs, direct costing, standard costs; estimated and statistical costs; distribution costs; contribution to overhead theory; depreciation and replacement of equipment; selection of plant; decision to make or buy; relation between costs and pricing policy. ¾ unit. Prerequisite: Business Administration 560 or equivalent.

563. **Controllership.** The controller in the business organization: his property control responsibilities; internal check; internal audits; insurance; his assistance to operating management through budgeting, break-even analysis, profitability

studies; his relationship with groups outside of management such as investors and government agencies; emphasis on manner in which figure function of controller is used to integrate the operations of the business enterprise. ¾ unit. Prerequisite: Business Administration 562 or equivalent.

570. Mathematical Analysis for Business Decisions. The use of classical mathematics in business decision-making; development of the concepts of total and marginal value analysis. Special emphasis is placed on the construction of quantitative models of business and economic systems, topics in bivariate and multivariate functions, differentiations, and integration. ¾ unit. Prerequisite: Enrollment in a graduate program.

571. Decision Theory. Application of finite mathematics to business decision-making; an introduction to the theory of sets; partitions and counting; vectors and matrices, as well as Bayesian statistics. Major emphasis is placed on linear programming and the theory of games. ¾ unit. Prerequisite: Enrollment in a graduate program.

572. Modern and Classical Statistics for Business Decisions. The application of classical and modern statistics for business decision-making; topics in probability distributions, variance analysis, and partial and multiple correlation analysis as well as the use of personal probabilities and utility theory. ¾ unit. Prerequisite: Business Administration 571.

573. Introduction to Operations Research. An introduction to operations research techniques; topics in integer, nonlinear, and dynamic programming, queueing theory, replacement, and Monte Carlo techniques; special projects in game theory applications in business. ¾ unit. Prerequisite: Business Administration 572; completion of first year of the M.B.A. program.

574. Application of Operations Research Techniques. The application of the operations research techniques developed in Business Administration 573 to practical business problems. Most of the semester is devoted to a series of field research studies. Prior to the field studies, a review of previous work in the field is made. The role of the computer in solving operations research problems, as well as its application to the field research, is also a major consideration. ¾ unit. Prerequisite: Business Administration 573.

575. Business Simulation. An introduction to the use of computers in solving business problems. Topics include the relation of integrated data processing systems to information flows within the firm and the development of simulation models of intrafirm decision processes. ¾ unit. Prerequisite: Business Administration 573.

576. Business Forecasting and Econometrics. An introduction to maximum likelihood estimating techniques. Topics include the use and limitations of least squares, two-stage least squares, limited-information and full-information estimates. Problems with observational errors, multi-colinearity, and auto-correlation in time-series and cross-section structural estimation are considered. A major portion of the course is devoted to the application of the econometric techniques in business forecasting and analysis. ¾ unit. Prerequisite: Business Administration 572.

582. International Business Operations, I. An integration of economics and the functional areas of business focused on the problems of managing international business operations. Economic, legal, functional, and administrative problems are studied through cases and literature emphasizing financial and marketing problems. Students select one of Europe, Latin America, Africa, Middle and Near East, or South Asia and Far East, for special study and reporting. ¾ unit. Prerequisite: Completion of first year of the M.B.A. program.

583. **International Business Operations, II.** Continuation of Business Administration 582. ¾ unit. Prerequisite: Business Administration 582.

590. **Independent Study and Research.** Directed reading and research. ½ or 1 unit.

599. **Thesis Research.** Individual direction of research and thesis writing. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

373. **Electronic Data Processing for Business.** A course in the fundamentals of business data processing. The use of modern electronic computers in the areas of accountancy, economics, management, marketing, and general business is considered. The facilities of the Digital Computer Laboratory are utilized in the course. ½ or 1 unit. Prerequisite: Economics 170; Accountancy 166 or 108. HINOMOTO, NOLAN.

374. **Operations Research.** Introduction to methods of operations research from an executive or managerial viewpoint, emphasizing formulation of business problems in quantitative terms. Industrial applications of linear programming and dynamic programming, game theory, probability theory, queueing theory, and inventory theory. ½ or 1 unit. Prerequisite: Economics 173 and Industrial Administration 210, or consent of instructor.

Industrial Administration

COURSES FOR GRADUATES

401. **Scientific Management, I.** Same as Industrial Engineering 401. A study of modern management principles on the basis of quantitative methods, concentrating on such operations research techniques as nonlinear and dynamic programming and queueing theory. 1 unit. Prerequisite: Industrial Engineering 386 and Mathematics 361, or consent of instructor.

402. **Scientific Management, II.** Same as Industrial Engineering 402. A systems approach to industrial problems involving inventory control, scheduling and line balancing, maintenance and investment theory; application of formally accumulated knowledge of operations research techniques. Problems from industry are assigned to small teams of students. 1 unit. Prerequisite: Industrial Administration or Industrial Engineering 401; background in computer technology or consent of instructor.

410. **Organizational Sciences, I.** Same as Political Science 460, Psychology 453, and Sociology 456. An introduction to the principal theories and important empirical research in various disciplines that study organizations. In addition to examination of the subject matter content of various disciplines, students critically examine the capacities and limitations of the various fields to make contributions to the study of organizations. 1 unit. Prerequisite: Enrollment as a major in organizational sciences in a cooperating program or approval of instructor.

411. **Organizational Sciences, II.** Same as Political Science 461, Psychology 454, and Sociology 457. An introduction to the principal theories and important empirical research in various disciplines that study organizations. In addition to examination of the subject matter content of various disciplines, students critically examine the capacities and limitations of the various fields to make contributions to the study of organizations. 1 unit. Prerequisite: Industrial Administration 410.

416. Problems in Business Policy. Advanced problems in policy evaluation, determination, execution, administration, and control. Policy objectives in integration of product, marketing, manufacturing, finance, and organization. 1 unit. Prerequisite: Consent of instructor.

448. Problems of Personnel Management. Same as Labor and Industrial Relations 448. An examination of the organization and administration of the personnel function in management. This course deals with the relations of personnel administration to operating departments, and the scope of business and industrial personnel services. Analytical appraisal of policies and practices in selected areas of personnel administration, such as selection and training, is carried out through case studies and direct industrial contracts. Specific consideration is given to problems up to and including placing the person on a job. 1 unit. Prerequisite: Industrial Administration 351 or equivalent, or consent of instructor.

449. Problems of Personnel Management. Same as Labor and Industrial Relations 449. A seminar and laboratory course dealing with the problems and practices encountered by personnel managers subsequent to the employment process. Students do field work in businesses and industries in the area on such topics as incentives, rating, employee services, and community relations. 1 unit. Prerequisite: Industrial Administration 351, 448, or equivalent.

491. Seminar in Special Topics. For lectures in topics of current interest not covered by regular course offerings. Subjects will be announced in the Time Table. ¼ to 1 unit. Prerequisite: Consent of instructor or department head.

499. Thesis Research. 1 unit. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Business Torts. Liability of businessmen for their wrongful acts and those of their agents arising separate and apart from their liabilities under contracts; covering their duties to business visitors, invasion of one's right of privacy, conspiracy, slander, libel, malpractice, including breach of contract. ¾ or 1 unit. Prerequisite: Industrial Administration 200, 201, or 261.

301. The Law of the Uniform Commercial Code. A continuation of the private law of business dealing with significant phases of the law of commercial transactions under the Uniform Commercial Code—sales, commercial paper, bank collections and deposits, bulk transfers, and security devices. Also included is the law of bailments, suretyship, and security in real property. ¾ or 1 unit. Prerequisite: Industrial Administration 201 or 261.

302. Wills, Estates, and Trusts. A study of the basic legal and management principles and practices involved in the planning and administration of wills, estates, and trusts. ¾ or 1 unit. Prerequisite: Industrial Administration 200, 201, or 261.

311. Administrative Policies and Organization. Development of administrative organization and the determination of policies for the integration of major activities of a business enterprise. ½ or ¾ unit. Prerequisite: Industrial Administration 210; Marketing 201.

315. Management in Manufacturing. The application of production concepts and quantitative techniques to actual industrial problems; the mathematical structure of the particular production problems and the general structure of the production system and its interaction with marketing and budgeting. Areas include inventory control, production processes, programming and production control, forecasting of production levels, simulation of the production system,

and physical planning of industrial plants. ½ unit. Prerequisite: Industrial Administration 213.

321. **Industrial Social Systems, I.** Same as Labor and Industrial Relations 321. Particular forms of individual and group behavior in organizations within the constraints of the economic, social, technological, and physical environment; the relations between union and management; the interdependency of these factors with the decisions managers make. ½ to 1 unit. Prerequisite: Industrial Administration 210; Psychology 100; Psychology 201 or consent of instructor.

323. **Industrial Social Systems, II.** Understanding of complex organizations; particular attention to ways of dividing work, achieving coordination, and issues connected with change and adaptation. ½ to 1 unit. Prerequisite: Industrial Administration 321; Psychology 201.

351. **Personnel Administration.** A study of concepts and methods used by the staff personnel unit in building and maintaining an effective work force in an industrial organization; development of ability to design the personnel subsystem within the firm and to deal effectively with problems encountered in such areas as recruitment, selection, training, and wage and salary administration; considerable emphasis upon case analysis, role playing, and research. Credit is not given for Industrial Administration 351 and Psychology 145 or 245. ½ to 1 unit. Prerequisite: Economics 173 and 240; Industrial Administration 323.

353. **Industrial Relations Administration.** An investigation of union-management relations primarily at the company level for those planning careers in the industrial labor relations field; topics include grievance handling, disciplinary policies and procedures, arbitration and contract negotiations; emphasis is given to case study and role playing techniques. ½ to 1 unit. Prerequisite: Industrial Administration 323; Economics 240.

Marketing

COURSES FOR GRADUATES

401. **Marketing Theory and Systems.** A detailed study of macro- and micro-marketing systems and the various approaches to marketing theory; attention is given to general systems theory, the nature of marketing systems, system adaptation to the environment, concepts of theory, and major approaches to macro and micro theory in marketing. 1 unit.

402. **Development of Marketing Thought.** The emphasis in this course is placed on an analysis of marketing thought from the late 1800's to the present. Although attention is directed primarily to general marketing and marketing management, consideration is also given to major contributions in selected areas of marketing. The literature and scholars selected are evaluated both as reflections of their times and as contributions or contributors to contemporary thought. 1 unit. Prerequisite: Marketing 401.

407. **Comparative Marketing Systems.** Examination of comparative marketing systems. Topics include specification and identification of structural elements of systems, analysis of static and dynamic properties, methods of analyzing systems such as input-output and flow analysis, the role of marketing in comparative economic systems, and the role of marketing in developing economies. 1 unit. Prerequisite: Marketing 401.

415. **Foundations of Consumer Behavior.** A study of basic factors influencing consumer behavior. Attention is focused on psychological, sociological, and economic variables, including motivation, learning, attitude, personality, small

groups, social class, demographic factors, and culture, to analyze their effects on purchasing behavior. 1 unit.

416. Consumer Information Processing. Analysis of information flows between buyer and seller; informational properties of demand stimulation strategies are considered from the viewpoints of the firm, consumer, and society; consumer decision making is examined drawing upon the psychology and sociology of buyer motivation and social influence. 1 unit. Prerequisite: Marketing 415.

421. Marketing Strategy: Theoretical Foundations. A formal analysis of strategy drawing on concepts from the theory of games, decision theory, value theory, and information theory. Topics covered are elements of game models, classes of decision problems, games against nature, modern utility theory, information theory, group decision making, statistical decision theory, and linear and nonlinear optimization. 1 unit.

422. Marketing Strategy: Decision Models. The role of models in the design, implementation, and adjustment of seller strategy; application of simulation, programming, and other methods to the specification and solution of product price, promotion, and other marketing problems. Topics covered include the nature of models and model building, forecasting models, optimization models, and other decision models. 1 unit. Prerequisite: Marketing 421.

472. Multivariate Methods in Marketing. The use of multivariate statistical methods in marketing research. Topics covered include multiple regression and correlation, analysis of variance and covariance, canonical correlation, discriminant analysis, factor analysis, and simultaneous methods such as two-stage least squares and limited information one-maximum likelihood. 1 unit. Prerequisite: Economics 470.

473. Experimental Design. Training in the design, execution, and interpretation of field and laboratory experimental research. Emphasis is placed on the evaluation of alternative designs, execution of problems, and interpretation of data; a review of illustrative research studies is made, an actual study is designed, and data is collected and interpreted. 1 unit.

474. Survey Methods in Marketing Research. An analysis of survey methods in marketing with emphasis on sample design, data collection, and data processing; an advanced course in the methods required to design, implement, and evaluate a research project. 1 unit. Prerequisite: Economics 171 or equivalent.

490. Seminar in Marketing. A special topics course in the general area of marketing. Topics are selected by the instructor at the beginning of each semester. 1 unit.

493. Research in Special Fields. ¼ to 2 units.

499. Thesis Research. Thesis or independent study in the field of marketing. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

Note: Marketing majors do not receive graduate credit for courses in the 300 series.

320. Marketing Research. An investigation of the development and applicability of information systems techniques to marketing problems. The marketing management process is analyzed; the underlying concepts related to the information needed to serve the processes are explored; and the incorporation of information resources into the management function is demonstrated. This course covers the use of behavioral sciences research methods, social processes and structure influences upon marketing activities, demographic variables, application of Bayesian decision theory, studies of promotional activity, simulation and programming models, planning models, and strategy formulation models

which provide an analytical structure for the solution of marketing problems. ½ unit. Prerequisite: Marketing 201.

337. Advertising and Sales Management. Designed to enable the student, through directed and supervised investigation of selected psychological, economic, and sociological problems, to become acquainted with the methods of demand analysis and its application to the interrelationships of marketing management, advertising management, and sales management. Discussion of communication theory as it relates to the goals and means of winning patronage for the firm. Emphasis is on the effect, or control, of the communication process. Class discussion is focused upon literature in demand stimulation and communications and the testing of relevant hypotheses. ½ unit. Prerequisite: Marketing 201.

344. Consumer Market Behavior. An analysis of consumer motivation, buying behavior, market adjustment, and product innovation, including a survey of explanatory theories of consumer market behavior and producer reactions. This course covers behavioral aspects of the marketing process from the producer to ultimate user, or consumer. Fundamentals of product planning, development, engineering, and promotion are viewed as part of the total marketing program. Normative models of the decision-making process for winning patronage in intermediate, industrial, and consumer markets are considered. The decision-making process by consumers is evaluated with reference to psychological drives used by producers, middlemen, and consumers. ½ unit. Prerequisite: Marketing 201.

352. Pricing Policies. The essential nature of marketing decisions and pricing, marketing organization and the pricing process, price theories and pricing models; contributions of operations research and behavioral sciences to pricing analysis; the relationship of pricing objectives, methods, strategies, and policies to market behavior and the goals of the firm. ½ unit. Prerequisite: Marketing 201.

360. Marketing Logistics. The ecology, analysis, and development of integrated distribution systems; the application of quantitative tools, economic analysis, transportation and marketing management in the analysis, and interpretation and design of the physical flow of goods through marketing network alternatives. Attention is given to the theory of market structures, transport networks, location, and cost control. Consideration is also given to site selection, warehousing, inventory management, logistic communications networks, and data control models. ½ unit. Prerequisite: Marketing 201.

370. International Marketing. The role of enterprise, comparative marketing, and transport institutions and systems, and comparative marketing organizations and systems of administration in selected foreign countries and the United States; the managerial and operational problems of world enterprise, with emphasis on the role of ethnic and cultural differences in influencing marketing strategy. ½ unit. Prerequisite: Marketing 201; consent of instructor.

380. Advanced Marketing Management. The appraisal and diagnosis, organization and planning, action and control of commodity and product-service distribution, marketing analysis and systems, and demand stimulation; a survey of normative models for decision-making in a variety of marketing situations and systems; introduction to the behavioral theory of the firm and its application to different marketing targets, institutional settings, or market arrangements; discussion of the various analytical tools available to firms for appraising, diagnosing, organizing, planning, and formulating market strategies. Principles of behavioral sciences and quantitative techniques are emphasized. A terminal course that integrates the analysis of a wide range of marketing problems and situations. ½ unit. Prerequisite: Marketing 320 and 337.

CERAMIC ENGINEERING

The Department of Ceramic Engineering offers work leading to the Master of Science and Doctor of Philosophy in Ceramics or in Ceramic Engineering. The prerequisite for graduate study in these areas is proficiency in the undergraduate courses required for the Bachelor of Science in Ceramic Engineering at the University of Illinois, or acceptable equivalents.

A minimum grade-point average of 3.75 for the last sixty hours of undergraduate work is required for admission. Students with grade-point averages between 3.75 and 4.0 are considered on an individual basis. Students who have bachelor's degrees in chemistry, physics, geology, or engineering may become candidates in this department.

A candidate for the Master of Science in Ceramics or Ceramic Engineering must complete a minimum of eight units of graduate work including a thesis.

Candidates for the Doctor of Philosophy in Ceramics must present the equivalent of the courses in chemistry, mathematics, physics, and ceramics listed in the undergraduate engineering curriculum.

Candidates for the Doctor of Philosophy in Ceramics or Ceramic Engineering are required to complete first the M.S. thesis (or give equivalent evidence of research) ; they must also pass the departmental qualifying examination.

Minors selected by graduate students in ceramics or ceramic engineering are chemistry, physics, mathematics, geology, or other engineering disciplines.

Students majoring in chemistry, physics, engineering, and other departments may take sole or second minors in ceramics or ceramic engineering. A second minor requires no ceramics prerequisite.

GRADUATE FACULTY

Professors: A. L. Friedberg (Head of Department), A. W. Allen, C. G. Bergeron, R. L. Cook, J. A. Nelson, F. V. Tooley.

Associate Professors: S. D. Brown, W. S. Williams, T. A. Willmore.

Assistant Professor: G. P. Wirtz.

COURSES FOR GRADUATES

401. Ceramic Chemistry. Silica, silicates, fusions, and phase relations. 1 unit. Prerequisite: Courses in chemistry and physics.

402. Ceramics. Chemical and physical phenomena. 1 to 2 units. Prerequisite: Courses in physics and chemistry.

405. Glass Technology. This course, following a brief review of unit processes and operations in glass manufacture, treats from a dominantly theoretical and research point of view selected major topics relating to the glass preparation process and the chemical, mechanical, optical, and electrical properties of glass. ¾ or 1 unit; for students electing the course for 1 unit, extra contact hours are arranged. Prerequisite: Ceramic Engineering 301 or equivalent, or consent of instructor. Tooley.

406. Glass Technology. This course is dominantly theoretical in approach. Following a survey of the basic theoretical ideas that have been used in the development of the glass model, student readings and reports from the classical and modern literature serve as the basis of class discussions on glass structure and behavior, with emphasis on structure property correlations. ¾ or 1 unit; for students electing the course for 1 unit, extra contact hours are arranged. Prerequisite: Ceramic Engineering 405 or consent of instructor. Tooley.

407. Porcelain Enamels. This course covers the fundamental scientific principles involved in the area of porcelain enameling and the properties of such coatings. 1 or 1½ units (includes laboratory if taken for more than 1 unit). Prerequisite: Ceramic Engineering 222 and 320, or equivalent.

409. Whitewares. Advanced study in the field of whitewares, including fundamental considerations of glazes and all types of ceramic bodies. Special emphasis is placed on new developments in research and processing. Considerable attention is given to the ferroelectric and ferromagnetic properties of electronic ceramics. 1 or 1½ units (includes laboratory if taken for more than 1 unit). Prerequisite: Ceramic Engineering 309; Ceramic Engineering 340 or equivalent. COOK.

410. Dielectric Properties of Ceramic Materials. Fundamental properties of vector fields are reviewed. The reaction of insulating solids to external electric fields is considered in terms of dielectric theory. The properties of ceramic dielectrics including ferroelectrics are treated in terms of present theory. The piezoelectric properties of ferroelectric crystals and ceramics are correlated with the crystal structure, microstructure, and the ferroelectric properties. ¾ or 1 unit; for students electing the course for 1 unit, extra contact hours are arranged. Prerequisite: Mathematics 345 and 348, or consent of instructor. TENNERY.

412. Structural Physical Ceramics. Structural chemistry and crystallization behavior of ceramic systems at elevated temperatures; nucleation, crystal growth; mineral synthesis; high-temperature reaction kinetics, including phase transformations and diffusion. ¾ or 1 unit; for students electing the course for 1 unit, extra contact hours are arranged.

414. Physical Chemistry of Clays and Soils. Same as Agronomy and Mining Engineering 414. The application of physical chemical principles and concepts to surfaces and adsorption on surfaces. Silicate surfaces and water adsorption are emphasized. 1 unit. Prerequisite: Chemistry 340 and 341, or equivalent, or consent of instructor.

421. High-Temperature Technology. A review of the methods of achieving and controlling high temperatures, both in industrial processes and in the laboratory, combined with a study of the techniques for measuring the properties of materials at elevated temperatures emphasizing oxides, carbon and graphite, silicates, carbides, borides, silicides, nitrides, sulfides, cermets, and refractory metals. A correlation of the physical and chemical behavior of these materials with their crystal structure, microstructure, and physical form is emphasized where possible. ¾ unit. Prerequisite: Ceramic Engineering 310. ALLEN.

422. High-Temperature Technology Laboratory. Laboratory to accompany Ceramic Engineering 421, with emphasis on instrumentation for and measurement of properties at elevated temperature. Analytical interpretation of data in numerical problems is included. ½ unit. Prerequisite: Credit or registration in Ceramic Engineering 421, or consent of instructor. ALLEN.

461. Mineralogy of Clays. Same as Geology 461. The composition of various types of clays; the structure and properties of the clay minerals; the origin and mode of occurrence of the clay minerals and clay materials. 1 unit. Prerequisite: Geology 336 or Chemistry 328, or equivalent; consent of instructor. GRIM.

462. Mineralogy of Clays. Same as Geology 462. The properties of clay materials, their relation to the structure of the clay minerals, methods of determination and control; the utilization of clays in various arts and industries. 1 unit. Prerequisite: Geology 461. GRIM.

495. Materials and Special Problems. Conference and laboratory. 0 to 2 units.

498. Seminar in Ceramics. Lectures on current ceramic research and development. Presentations by visiting lecturers as well as graduate students and staff in the

department. Registration required of all graduate students in ceramic engineering. Graduate students nearing completion of their theses are required to make a seminar presentation. No credit. Prerequisite: Graduate standing in ceramic engineering.

499. Thesis Research. Research in any of the branches of ceramics. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Advanced Chemistry and Technology of Glass. This course augments some of the subject matter of Ceramic Engineering 214, and develops additional subject matter relating to the theory of glass formation and structure and the behavior of glass as a function of composition, structure, and heat treatment. Students taking this course gain improved qualifications for research work in the field. ½ unit. Prerequisite: Ceramic Engineering 214 or consent of instructor. TOOLEY.

307. Thermal and Mechanical Properties of Ceramic Materials. Interpretations of the thermal and mechanical behavior of real ceramic materials utilizing the atomistic concepts of structure correlated with characterized microstructure. Half of the course treats the mechanism of thermal dilatation, heat transport and emission. The remainder integrates the characterization of deformation including elastic, anelastic, plastic, and viscous behavior. Temperature dependency is stressed throughout. Lectures and laboratory. ¾ unit. Prerequisite: Ceramic Engineering 216, 331, or equivalent; Theoretical and Applied Mechanics 154 and 221. BROWN.

309. Whiteware Materials. A study of the characteristics and engineering properties of multi-phase polycrystalline aggregates and vitreous complexes including the raw material preparation, fabrication, and processing. Special emphasis is placed on the single and multi-oxide component bodies, including the crystallographic structures of the alkaline earth titanates and the ferritic spinels as whiteware materials. ¾ unit. Prerequisite: Ceramic Engineering 216 or equivalent. COOK.

310. Refractory Technology. A study of the engineering properties and thermochemistry of polycrystalline materials for use at elevated temperatures, including processing of raw materials, the manufacture, heat treatment, quality control, and specification of refractory products. Particular emphasis is placed on oxides, silicates, carbides, borides, cermets, and refractory metals, with a correlation of the properties of those materials to certain design criteria. ¾ or 1 unit (includes laboratory if taken for 1 unit). Prerequisite: Ceramic Engineering 307. ALLEN.

311. Ceramic X-Ray Analysis. The use of x-ray diffraction for phase identification, for the determination of crystalline lattice parameters, and for the determination of the thermal expansion of crystalline solids is discussed; analytical methods of indexing powder diffraction patterns are covered; the determination of precise lattice parameters by means of computer programming and high temperature x-ray techniques is reviewed. ¾ unit. Prerequisite: Mathematics 195; senior standing in the departments of Engineering, Chemistry and Chemical Engineering, or Geology, or consent of instructor. TENNERY.

320. Advanced Porcelain Enamels. An advanced study of the field of porcelain enamels with particular emphasis on fundamentals of bond or adherence of enamel metal systems, on opacity and mechanism of color development and measurement, and on the thermal and chemical properties of coatings on metal. Specific attention is given to coatings for use on metals at elevated temperatures. ½ or ¾ unit. Prerequisite: Ceramic Engineering 222 or consent of instructor. COOK.

331. Ceramic Microscopy. A study of the optical activity in isotropic and anisotropic media with particular emphasis on the materials and products of ceramics; the application of these principles and related topics of optical microscopy to the study of the morphology, aggregation, size, and microstructure of the products of high-temperature thermochemical reactions and equilibria. ¾ or 1 unit (includes studies in thermal microscopy if taken for 1 unit). Prerequisite: Ceramic Engineering 205 and 216, or consent of instructor. ALLEN.

340. Electrical Ceramics. The subject of dielectric crystals and their electrical properties is presented; the ferroelectric and piezoelectric properties of several crystal classes are discussed and correlated; the perovskite class of ferroelectric compounds is covered in detail; spinel, garnet, and hexagonal type ferrimagnetic crystals and their properties are discussed. ¾ unit. Prerequisite: Ceramic Engineering 309 or consent of instructor. TENNERY.

CHEMICAL PHYSICS

Fundamental research on many properties of molecular and solid state systems is based on an understanding of chemistry, physics, and mathematics that can best be obtained by training in more than one department of the University. A program leading to the Doctor of Philosophy in Chemical Physics makes it possible for students to gain the necessary background and perform original research in this interdisciplinary field of science.

Applicants for admission should have undergraduate degrees in chemistry or physics, a grade-point average of at least 4.0, and a strong background in the major field of chemistry or physics, with more than the usual training in the other area. Those who received their degrees in physics should have the equivalent of one semester each of organic and inorganic chemistry and one year of physical chemistry. Those who received their degrees in chemistry should have the equivalent of one semester each of intermediate mechanics and intermediate electricity and magnetism. One year of mathematics beyond calculus is recommended. Deficiencies should be removed during the first year of study.

In addition to satisfying the requirements of the Graduate College, students must pass either the qualifying examination in the Department of Physics or the set of cumulative examinations given by the Division of Physical Chemistry. A knowledge of the content of Chemistry 348 and 349 or Physics 362 and 381 must be demonstrated also (for example, by passing the final examinations in these courses).

Research for the dissertation is performed under the direction of staff members who are currently active in chemical physics. Students may apply for fellowships and assistantships and may make use of the facilities available in the departments of Chemistry and Chemical Engineering and Physics.

Students with undergraduate degrees in chemistry should direct inquiries and applications to the head of the Department of Chemistry and Chemical Engineering; students with undergraduate degrees in physics should direct inquiries and applications to the head of the Department of Physics.

CHEMISTRY AND CHEMICAL ENGINEERING

(Including Biochemistry)

The degrees offered in chemistry and chemical engineering are Master of Arts or Master of Science in Chemistry, Master of Science in Chemical Engineering, and Doctor of Philosophy in Chemistry or in Chemical Engineering. The courses offered in biochemistry and in chemical engineering are listed separately following those in chemistry. Attention is also called to a joint program leading to the Doctor of Philosophy in Chemical Physics (see above) and to the program in Biophysical Chemistry (see pages 102, 119, and 277).

Students who have fulfilled the usual undergraduate course requirements, including at least twenty-five semester hours in chemistry properly distributed, and who have a grade-point average of 4.0 or above, may apply for admission to the Graduate College in chemistry or chemical engineering. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

Students who have completed graduate work in chemistry or chemical engineering at another institution may be admitted if they have grade-point averages of 4.0 in both undergraduate and graduate work, or if they have earned a 4.25 average in at least eight units or a full year of graduate work at an accredited institution.

Graduate students whose major subject in the Graduate College is in a department other than Chemistry and Chemical Engineering may take chemistry courses for graduate credit if they have had the equivalent of fifteen semester hours of chemistry. Such students are advised to consult members of the staff in choosing courses appropriate to their backgrounds and objectives.

THE TEACHING OF CHEMISTRY

Candidates for the Master of Science in the Teaching of Chemistry must earn four units in chemistry, two units in education, and two units of electives in either education or physical science. The two units in education consist of the following courses: History and Philosophy of Education 304 and 305, and Educational Psychology 311 and 312. The courses in chemistry and the electives, which must normally give graduate credit, must be selected with the approval of the adviser. Students applying for admission must have a grade-point average of at least 3.5. Inquiries concerning this program should be directed to Professor D. H. Secrest, 155 Noyes Laboratory.

BIOCHEMISTRY

The Biochemistry Division of the Department of Chemistry and Chemical Engineering administers the graduate program in biochemistry. The curriculum is composed of Chemistry 350, 355, 450, 452, and 494 (same as Microbiology or Biophysical Chemistry 494), and selected offerings in allied chemical and biological areas. Interested students should direct inquiries and applications to the head of the Biochemistry Division.

BIOPHYSICAL CHEMISTRY

The Department of Chemistry and Chemical Engineering offers an area of specialization in biophysical chemistry. The program is flexible and provides the student with basic training in physical chemistry, physical biochemistry, and biology. Students electing this area should have a solid background in physics and mathematics. Details of the curriculum are decided individually. Interested students should direct inquiries and applications to the head of the Department of Chemistry and Chemical Engineering.

CHEMICAL ENGINEERING

Candidates for advanced degrees in chemical engineering should have had undergraduate training comparable to that offered in the undergraduate chemical engineering curriculum at the University of Illinois. Students who enter without the usual engineering courses are required to make up their deficiencies to the extent prescribed by their adviser. Candidates for the Master of Science must include two chemical engineering courses at the 400 level in their programs. Interested students should direct inquiries and applications to the head of the Chemical Engineering Division.

GRADUATE FACULTY

Professors: H. S. Gutowsky (Head of Department), D. E. Applequist, J. C. Bailar, Jr., H. P. Broquist, T. L. Brown, H. E. Carter, D. Y. Curtin (Associate Head of Department), R. S. Drago, H. G. Drickamer, W. H. Flygare, I. C. Gunsalus, L. P. Hager, G. P. Haight, Jr., T. J. Hanratty, J. P. Hummel, H. A. Laitinen, N. J. Leonard, H. V. Malmstadt, R. A. Marcus, J. C. Martin, T. Moeller, R. F. Nystrom, J. A. Quinn, K. L. Rinehart, H. R. Snyder, G. Weber, J. W. Westwater, P. E. Yankwich.

Associate Professors: P. Beak, R. L. Belford, J. M. Clark, H. E. Conrad, A. M. Hartley, R. S. Juvet, I. C. Paul, R. A. Schmitz, G. J. Schroepfer, Jr., D. H. Secrest, S. G. Smith, G. D. Stucky.

Assistant Professors: J. K. Beattie, V. A. Bloomfield, R. M. Coates, K. M. Dus, C. A. Eckert, W. T. Ford, J. Goodisman, J. L. Hudson, J. Jonas, J. R. Lombardi, W. H. Pirkle, R. L. Sani, R. L. Switzer, J. M. Wood, R. W. Woody, J. T. Yardley.

Chemistry

COURSES FOR GRADUATES

402. Inorganic Chemistry. The less familiar elements and their relationship in the periodic system. Lectures, reports, and assigned readings. 1 unit.

404. Advanced Inorganic Chemistry Laboratory. Specialized laboratory techniques; more difficult inorganic syntheses. ¼ to ¾ unit. Prerequisite: Credit or registration in one of the lecture courses in inorganic chemistry in the 400 series.

405. Inorganic Chemistry. Seminar. Required of all graduate students whose major is inorganic chemistry. ¼ unit.

406. Physical Inorganic Chemistry. Qualitative description of the bonding in inorganic compounds; use of physical methods to provide information about the structure and reactions of inorganic compounds; structures and reactions of inorganic compounds in solution. 1 unit. Prerequisite: Chemistry 315 and 344.

407. Special Topics in Inorganic Chemistry. An advanced course dealing with a subject not ordinarily covered by regularly scheduled courses, such as organometallic chemistry, advanced ligand theory and molecular orbital theory of inorganic reactions, etc. ½ to 1 unit. Students may repeat this course for credit. Prerequisite: Chemistry 406 or consent of instructor.

408. The Chemistry of Complex Inorganic Compounds. The nature of the coordinate bond; applications of complex compounds. 1 unit. Prerequisite: Chemistry 315.

421. Spectrochemical Methods of Analysis. Emission spectroscopy; Raman spectroscopy; mass spectrometry; ultraviolet, visible, infrared, and microwave absorption spectroscopy; colorimetry, fluorimetry, interferometry, and polarimetry. Lectures and laboratory. 1 unit. Prerequisite: General physics and chemistry equivalent to a major for a bachelor's degree.

422. Electrical Methods of Chemical Analysis. Polarography, potentiometric, amperometric, conductometric titrations, and other selected topics. Lectures and laboratory. 1 unit. Prerequisite: Chemistry 344 or equivalent.

423. Electron Microscopy. Same as Biology 423. Lectures, discussions, and demonstrations on the physical principles and electron optics of the transmission of electron microscopes and its modern variants, including lectures and demonstrations of modern high vacuum techniques. Open to qualified graduate students in all departments. ½ unit. Prerequisite: A course in modern physics or physical chemistry (having calculus as a prerequisite) affording an introduction to wave mechanics, or consent of instructor.

424. Quantitative Analysis. Advanced principles, including chemical statistics, calculations, experimental methods, and applications. ½ unit.

425. Analytical Chemistry. Seminar. Required of all graduate students whose major is analytical chemistry. ¼ unit.

427. Applied X Rays: Crystallography. Lectures. ¾ unit. Prerequisite: Training in physics and physical chemistry.

429. Electron Microscopy with Laboratory. Same as Biology 429. General lectures on theory and design of electron microscopes without mathematical derivations; discussion and practice on specimen preparation; operation of electron microscopes with separate sections to meet special needs of biologists, geologists, and those interested in electron diffraction. (Most theory lectures may be omitted by those enrolled or having credit in Biology or Chemistry 423.) Open to qualified graduate students in all departments. 1 unit. Prerequisite: Two semesters of general physics, two semesters of college mathematics, and three semesters of chemistry, or consent of instructor.

430. Organic Chemistry. Survey of organic chemistry for graduate students. 1 unit. Prerequisite: One year of organic chemistry.

431. Organic Chemistry. Advanced survey of organic chemistry with emphasis on reaction mechanisms and synthesis. 1 unit. Prerequisite: Chemistry 430 or 336; one year of physical chemistry.

432. Organic Chemistry. Advanced survey of organic chemistry with emphasis on structure. 1 unit. Prerequisite: Chemistry 431 or 336.

433. Organic Chemistry. Special topics in organic chemistry. An advanced course dealing with a subject not ordinarily covered by regularly scheduled courses, such as natural product synthesis and biosynthesis, organic photochemistry, chemistry of special families of organic compounds, etc. ½ or ¾ unit; ¾ unit requires two lectures per week. Students may repeat this course for credit. Prerequisite: Chemistry 431 and 432, one of which may be taken concurrently.

434. Advanced Organic Synthesis. Lecture and laboratory. ¼ to 1 unit.

435. Organic Chemistry. Seminar. Current literature in organic chemistry. ½ unit. Prerequisite: Consent of instructor.

436. Experimental Organic Chemistry. A lecture course on research techniques in organic chemistry. ¼ unit. Prerequisite: Consent of instructor.

441. Chemical Thermodynamics. Fundamental laws of thermodynamics and their molecular interpretation; determination and chemical use of thermodynamic quantities. 1 unit. Prerequisite: Chemistry 342 and 344, or equivalent.

442. Statistical Thermodynamics. Basic principles of classical and quantum statistics with applications to chemistry. 1 unit. Prerequisite: Chemistry 441 and 446, or consent of instructor.

443. Quantum Dynamics. The quantum mechanical description of time-dependent processes, including discussions of time-dependent Schrödinger equation, approximations, interaction of matter with radiation, wave packets, elastic and

inelastic scattering, and relaxation phenomena. 1 unit. Prerequisite: Registration in Chemistry 349 or consent of instructor.

445. Physical Chemistry. Seminar. Required of all graduate students whose major is physical chemistry. ¼ or ½ unit. Prerequisite: Consent of instructor.

446. Molecular Quantum Mechanics. The quantum mechanical description of atoms and molecules including discussions of angular momentum and group theory, approximate methods for the determination and interpretation of atomic and molecular wave functions, and the calculation of physical and chemical properties and spectra. 1 unit. Prerequisite: Registration in Chemistry 349 or consent of instructor.

448. Chemical Kinetics. Chemical reaction and theory of rate processes. Lectures. ¾ unit. Prerequisite: Chemistry 441 or consent of instructor.

449. Special Topics in Physical Chemistry. An advanced course dealing with a subject not ordinarily covered by regularly scheduled courses, such as molecular spectroscopy, statistical mechanics, radiation and hot-atom chemistry, molecular quantum mechanics, radiofrequency spectroscopy, advanced experimental methods, kinetics of irreversible processes and cooperative phenomena, etc. ½ or 1 unit. Students may register for credit more than once. Prerequisite: Consent of instructor.

490. Special Topics in Chemistry. This course is designed for students majoring or minoring in chemistry who wish to undertake individual studies of a non-Ph.D. thesis nature, under the direction of a faculty member of the department. ¼ to 4 units. Prerequisite: Consent of instructor and of head of department. Staff for the course is the same as for Chemistry 499.

493. Advanced Electron Microscopy. Same as Biology 493. Conferences and practice dealing with specialized laboratory techniques, preparation of specimens, the analysis and study of varied materials by use of transmission and/or scanning electron microscopes and by the techniques of electron diffraction. Open to qualified students in all departments. ¼ to ½ unit. Prerequisite: Credit in Biology or Chemistry 429; consent of instructor.

494. Chemical Basis of Biological Specificity. Biological formation and interaction of large molecules; analysis of the structural features concerned with functional specificity in heteropolymers, viruses, and subcellular particles; nucleic acids and their role as genetic molecules; proteins in their role as genetic products with highly specific functions; metabolic interrelations of these molecules. ¾ unit. Prerequisite: Chemistry 344, 346, and 350, or 450; Microbiology 330; or consent of instructor.

496. The Use of Carbon-14 in Labeling Techniques. Same as Animal Science 496. A comprehensive study of the chemistry of carbon-14. The laboratory work deals with vacuum-line manipulations and synthesis, degradation, and assay of radioactive carbon compounds. ¾ or 1 unit. Prerequisite: Chemistry 336, 337, and 338, or equivalent; consent of instructor.

499. Thesis Research. A candidate for the master's degree who elects research is required to present a thesis in order to apply credit in chemistry 499 toward meeting the requirements of the degree. A thesis is always required of students working toward the Doctor of Philosophy. Not all candidates for thesis work necessarily are accepted. 0 to 4 units. Work may be taken in any of a wide variety of fields, subject to the approval of an appropriate staff member who serves as the student's thesis adviser. Much of present research involves more than one of the traditional fields and student programs are planned accordingly, often on a highly individual basis. Accordingly, the following listing of fields and staff is intended to be informative, but it is not all inclusive. Details

with respect to the programs possible are available from the various staff concerned and also from the head of the Department of Chemistry and Chemical Engineering.

Analytical Chemistry. Hartley, Jonas, Juvet, Laitinen, Malmstadt.
Biophysical Chemistry. Bloomfield, Gunsalus, Leonard, Paul, Rinehart, Weber, Woody.

Inorganic Chemistry. Bailar, Beattie, Brown, Drago, Haight, Moeller, Stucky.

Organic Chemistry. Applequist, Beak, Coates, Curtin, Ford, Leonard, Martin, Paul, Pirkle, Rinehart, Schroepfer, Smith, Snyder.

Physical Chemistry and Chemical Physics. Belford, Bloomfield, Drickamer, Flygare, Goodisman, Gutowsky, Hummel, Jonas, Lombardi, Marcus, Paul, Secrest, Woody, Yankwich, Yardley.

Radiochemistry. Hummel, Nystrom.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

315. Inorganic Chemistry. Nuclear and extranuclear atomic structures and their relation to the properties of the elements and their compounds; types of bonding; survey of the periodic relationships; preparation and applications of the elements and their compounds. ¾ unit. Prerequisite: Credit or registration in physical chemistry.

316. Inorganic Chemistry. Preparation of typical inorganic compounds illustrating special and more advanced techniques. ½ unit. Prerequisite: Credit or registration in Chemistry 315.

321. Instrumental Analysis. Advanced instrumental methods of chemical analysis and their application to the study of chemical reactions. ¾ unit. Prerequisite: Chemistry 340 or 342, and 383.

322. Separation Methods and Quantitative Organic Analysis. Theory and practice of gas, liquid, ion-exchange, and gel permeation chromatography, counter-current distribution, electrophoresis, and distillation; qualitative and quantitative interpretation of IR, mass, and NMR spectroscopy; quantitative methods of organic analysis via functional groups. ¾ unit. Prerequisite: Chemistry 336.

323. Applied Electronics for Scientists. A lecture and laboratory course designed expressly for chemists and other scientists or engineers who have little or no background in electronics, but who need a working knowledge of electronic devices, circuits, and instruments. The course begins with electronic principles and leads systematically into digital, analog, and servo systems used in scientific instrumentation. 1 unit. Prerequisite: Consent of instructor.

336. Organic Chemistry. Second course. Lectures and recitations. ¾ unit. Prerequisite: Chemistry 133 with a grade of A or B, or Chemistry 234 and 281.

337. Organic Chemistry. Laboratory experiments in organic chemistry. ½ unit. Prerequisite: Credit or registration in Chemistry 336.

338. Separation, Purification, and Identification of Organic Compounds. Separation, purification, and identification of organic compounds using modern research methods; the identification of organic compounds by the use of spectroscopic methods and chemical conversion; the separation of mixtures and the purification of the components by crystallization, sublimation, distillation, extraction, and chromatography; the qualitative and quantitative identification of the components of a mixture. 1 unit. Prerequisite: Chemistry 336 and 337.

339. **Theoretical Organic Chemistry.** Theoretical interpretation of reactivity, reaction mechanisms, and the nature of common reaction intermediates: carbonium ions, free radicals, and carbanions. ¾ unit. Prerequisite: Chemistry 338 or consent of instructor.

340. **Principles of Physical Chemistry.** A one-semester course in physical chemistry emphasizing topics most important to students in the biological and agricultural sciences. Not open to students in the specialized curricula in chemistry or chemical engineering. 1 unit. Prerequisite: Physics 102; Chemistry 122 and 133, or equivalent; Mathematics 132 or equivalent.

341. **Elementary Physical Chemistry Laboratory.** A laboratory course to accompany Chemistry 340. ¼ unit. Prerequisite: Registration in Chemistry 340 or credit for one semester of a lecture course in physical chemistry.

342. **Physical Chemistry.** To be taken concurrently with Chemistry 383. This course and Chemistry 344 constitute a year-long study of chemical principles, covering topics such as: atomic and molecular structure, properties and thermodynamics of gases, liquids, crystals, phase equilibria, solutions, surface chemistry, chemical equilibrium, electrochemistry, chemical thermodynamics, and chemical kinetics. Students who do not intend to take Chemistry 344 should not enroll in Chemistry 342. ¾ unit. Prerequisite: Chemistry 108, 122, 123, or equivalent; Physics 106, 107, and 108, or two semesters of general physics with concurrent registration in the third semester; credit or registration in Mathematics 142 or equivalent. STAFF.

344. **Physical Chemistry.** Continuation of Chemistry 342. To be taken concurrently with Chemistry 385. ¾ unit. Prerequisite: Chemistry 342. STAFF.

346. **Physical Chemistry of Macromolecules.** The physical properties of systems containing large molecules, with special emphasis on proteins, nucleic acids, and high polymers; the use of physical methods for the characterization of such substances. ¾ unit. Prerequisite: Chemistry 340 or 344.

348. **Advanced Physical Chemistry.** The sequence Chemistry 348 and 349 is designed to give seniors and graduate students a unified treatment of physical chemistry on an advanced level. Topics discussed are the electronic structure and spectra of atoms, principles of wave mechanics, experimental and theoretical aspects of the chemical bond in diatomic and polyatomic molecules, statistical thermodynamics, and chemical kinetics. 1 unit. Prerequisite: Chemistry 344 or equivalent.

349. **Advanced Physical Chemistry.** Continuation of Chemistry 348. 1 unit. Prerequisite: Chemistry 348.

383. **Dynamics, Structure, and Physical Methods.** A laboratory course presenting the relationship of dynamics and structure with emphasis on the use of physical methods to follow the course of reactions. ½ unit. Prerequisite: Registration in Chemistry 342; Chemistry 234 and 281; credit or registration in Physics 108 and Mathematics 142.

385. **Chemical Fundamentals.** A laboratory course with experiments on the fundamental physical nature of chemical phenomena. 1 unit. Prerequisite: Registration in Chemistry 344; Chemistry 342 and 383.

392. **Applied X Rays.** Generation and detection of x rays, absorption and scattering of x rays by matter; crystals, crystal and molecular symmetry; techniques of x-ray diffraction; identification and analyses; deduction of atomic positions. ¾ unit. Prerequisite: Chemistry 342 or consent of instructor.

394. **Applied X-Ray Laboratory.** Techniques of x-ray analysis; powder techniques; fluorescence analysis; Weissenberg, precession camera techniques; reduction of

film data; determination of crystal structure. ¼ to 1 unit. Prerequisite: Credit or registration in Chemistry 392, or consent of instructor.

395. **History of Science with Particular Reference to Chemistry.** ½ unit. Prerequisite: Twenty hours of laboratory science.

396. **Atomic Physics.** Same as Physics 381. A lecture and problem course presenting our modern knowledge of the nature and properties of electrons, light quanta, atoms and molecules. Topics discussed include evidence for the atomic nature of matter, the properties of free electrons and ions, photons and their interaction with matter, atomic spectra and structure, molecular spectra and structure, and an introduction to the ideas of quantum mechanics. 1 unit. Prerequisite: General physics and Mathematics 343 or 345. It is recommended that chemistry majors take Chemistry 344 before registering in this course; concurrent registration in Physics 385 is also recommended. A student may not receive credit for both Physics 381 (Chemistry 396) and Physics 386.

397. **Radiochemistry.** Same as Nuclear Engineering 397. Properties of radioactive nuclei, nature of radioactivity, nuclear structure, nuclear reactions, interactions of radiations with matter, chemical aspects of radioactivity work, and applications of nucleonics to chemistry. ¾ unit. Prerequisite: One semester of physical chemistry or one semester of atomic physics or consent of instructor.

398. **Radiochemistry Laboratory.** Same as Nuclear Engineering 398. To accompany Chemistry 397. Radioactivity detection and tracer applications of radioisotopes in chemistry and other fields. Laboratory and discussions. ½ unit. Prerequisite: One semester of physical chemistry or one semester of atomic physics or consent of instructor.

Biochemistry

COURSES FOR GRADUATES

450. **Chemistry of Biological Processes.** A consideration at the molecular level of biological processes including bioenergetics, biosynthetic and degradative pathways of cellular components, metabolic regulation and enzyme reaction mechanisms. 1 unit. Prerequisite: Biochemistry 350 and 355.

452. **Experimental Techniques in Biochemistry.** Experiments on the isolation, purification, and analysis of biological material, including proteins and enzymes. Methods of studying constituents of biological material; their degradation products, and the metabolic processes, including the isolation and characterization of intermediates. ¾ or 1 unit. Prerequisite: Biochemistry 350 and 355.

455. **Biochemistry.** Seminar. Discussions of current research and literature. Required of all graduate students whose major is biochemistry. ½ unit. Prerequisite: Biochemistry 350 and 355, or equivalent.

499. **Thesis Research.** 0 to 4 units. Bloomfield, Blumson, Broquist, Clark, Conrad, Foster, Dus, Gunsalus, Hager, McClure, Schroepfer, Switzer, Weber, Wood.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

350. **General Biochemistry.** The chemistry and reactions of constituents of living matter, including carbohydrates, lipids, proteins, nucleic acids, vitamins, coenzymes, and minerals; the chemistry and regulation of the reactions and processes of whole organisms, plant and animal, of organs, cells, and subcellular particles and soluble components. Lectures and assigned readings, ¾ unit. Prerequisite: Quantitative analytical chemistry, and Chemistry 133 or 234, or equivalent.

351. **Physicochemical Basis of Biochemistry.** An introduction to the physico-chemical methods and ideas underlying biochemistry. ¾ unit. Prerequisite: Chemistry 340, or equivalent, or consent of instructor.

354. **Introduction to Biochemistry.** Lectures: Structure and function of living matter, with emphasis on the mammalian organism. Laboratory: The isolation, chemical characterization, and function of the structural and catalytic components of living cells. This course is designed primarily to meet the needs of veterinary medicine, nutrition, dietetics, and other professional students. Open to other students only by special permission when space is available. This course does not meet the requirements for registration in advanced courses in biochemistry. 1 unit. Prerequisite: Quantative analytical chemistry, and Chemistry 133 or 234, or equivalent; laboratory course in general biology, botany, or zoology; or consent of instructor.

355. **Biochemistry Laboratory.** To accompany Chemistry 350. An introduction to experimentation with biochemical systems, processes, and compounds of biochemical importance; identification and quantitative measurement of constituents and transformations in biological systems. Laboratory, quizzes, and assigned readings. Required of all students who expect to take advanced courses in biochemistry. 1 unit. Prerequisite: Quantitative analytical chemistry, Chemistry 133 or 234, or equivalent; registration in Biochemistry 350.

Chemical Engineering

COURSES FOR GRADUATES

464. **Transport Phenomena.** Analysis of the various phenomena associated with transport processes; mechanism and phenomenological description; equations of change; interphase transport. Application to systems involving the transfer of energy, mass, and momentum. 1 unit. Prerequisite: Mathematics 345 or 343; Chemical Engineering 373 or consent of instructor.

465. **Chemical Engineering.** Seminar. Required of all graduate students whose major is chemical engineering. ¼ unit. Prerequisite: Chemical Engineering 373.

466. **Applied Mathematics in Chemical Engineering.** The development of mathematical models and a survey of modern mathematical methods currently used in the solution of chemical engineering problems. Topics include the application of vectors and matrices, partial differential equations, numerical analysis, and methods of optimization in chemical engineering. ¾ or 1 unit. Prerequisite: Consent of instructor.

468. **Properties of Fluids.** The kinetic theory of gases and the prediction of transport coefficients; statistical mechanics applied to dense gases and liquids; theories of solutions. ¾ or 1 unit. Prerequisite: A background in modern physical chemistry and physics; consent of instructor.

469. **Special Topics in Chemical Engineering.** Various advanced topics are covered from time to time. These are generally taken during the second year of graduate study. Typical topics include turbulence, hydrodynamic instability, process dynamics, interfacial phenomena, reactor design, properties of matter at high pressure, phase transitions. This course may be repeated for credit. ¾ or 1 unit. Prerequisite: Chemical Engineering 464.

487. **Fluid Dynamics.** Basic concepts in fluid dynamics with special emphasis on topics of interest to chemical engineers. Derivation of the Navier-Stokes equations; solutions for creeping flow, for perfect fluids, and for boundary layers; non-Newtonian fluids; turbulence. 1 unit. Prerequisite: Chemical Engineering 464.

488. **Advanced Topics in Heat and Mass Transfer.** Principles of transfer operations developed in terms of physical rate processes. Boundary layer heat and mass transfer, eddy diffusion, phase changes, and separation processes. ¾ or 1 unit. Prerequisite: Chemical Engineering 464 or consent of instructor.

499. **Thesis Research.** Candidates for the master's degree who elect research are required to write a thesis. A thesis is always required for the Doctor of Philosophy. Not all candidates for thesis work necessarily are accepted. Any student whose major is in another department must receive permission from the head of the Department of Chemistry and Chemical Engineering to register in this course. 0 to 4 units. DRICKAMER, ECKERT, HANRATTY, HUDSON, QUINN, SANI, SCHMITZ, WESTWATER.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

363. **Introduction to Process Engineering.** Same as Food Science 363. Fundamentals of heat transfer, fluid flow, evaporation, drying, and other unit operations in the process industries. For students in chemistry, engineering, and food science; not open to majors in chemical engineering. Lectures and problems. ¾ unit. Prerequisite: Calculus or consent of instructor.

367. **Introduction to Process Control.** An introduction to the control of industrial chemical processes. Lecture and laboratory. ¾ unit. Prerequisite: Mathematics 345 or 343; Chemical Engineering 371.

368. **Selected Topics in Chemical Engineering.** Study of selected topics in chemical engineering. The content of the course varies from semester to semester. Typical topics are optimization, chemical kinetics, phase equilibrium, biochemical engineering, kinetic theory and transport properties, etc. ¾ or 1 unit. May be repeated for credit. Prerequisite: Senior standing in chemical engineering or consent of instructor.

370. **Chemical Engineering Thermodynamics.** The fundamental concepts and laws of thermodynamics. Primarily for students in chemical engineering. ½ unit. Prerequisite: Chemical Engineering 261; Chemistry 342.

371. **Principles of Chemical Engineering.** Introduction to fluid dynamics and heat transfer. Lectures, problems, and quizzes. 1 unit. Prerequisite: Chemical Engineering 370 or consent of instructor.

373. **Principles of Chemical Engineering.** Introduction to mass transfer operations. Lectures, problems, and quizzes. 1 unit. Prerequisite: Chemical Engineering 371.

374. **Unit Operations Laboratory.** To accompany Chemical Engineering 373. Laboratory and computations in the unit operation. ½ unit. Prerequisite: Credit or registration in Chemical Engineering 373.

377. **Process Dynamics.** The basic ideas of process dynamics and their applications in chemical engineering. ¾ unit. Prerequisite: Chemical Engineering 367 or consent of instructor.

379. **Chemical Engineering Projects.** Laboratory. Development of an individual project. ½ unit. Prerequisite: Senior standing in chemistry or chemical engineering.

380. **Heat, Mass, and Momentum Transport.** A unifying treatment of physical rate processes with particular emphasis on the formulation and solution of typical boundary value problems associated with heat, mass, and momentum transport. ¾ unit. Prerequisite: Mathematics 343 or 345; Chemical Engineering 371; or consent of instructor.

381. Chemical Reactor Design. Chemical kinetics and chemical reactor design with consideration of the interrelationship between the reactor and heat and mass transfer equipment used in a chemical conversion. ¾ unit. Prerequisite: Chemical Engineering 373.

382. The Prediction of Physical Properties. The prediction of equilibrium and transport properties in gases, liquids, and solids. ½ unit. Prerequisite: One year of physical chemistry.

CIVIL ENGINEERING

(Including Sanitary Engineering)

The Department of Civil Engineering offers a combination of advanced study and participation in creative research to meet the needs of individual students. Such graduate training prepares students to assume greater responsibilities and to contribute to the progress of the civil engineering profession. Graduate study and research can be pursued in the fields of air pollution; analysis and design of structures; behavior of structures and properties of structural materials (concrete, steel, and other materials); construction engineering and management; digital computer applications to analysis or design; geodetic engineering; highway engineering; hydrology; hydromechanics and hydraulic structures; materials and structural design of roadways; models research; nuclear structural shielding; photogrammetry and photogrammetric engineering; radiological health; railway engineering; rock mechanics; soil mechanics and foundations; stream analysis; structural dynamics; design for earthquake, shock, and blast excitation; structural mechanics; systems analysis and design and operations; traffic engineering; transportation planning; urban planning and management; waste water treatment; water quality and treatment; and water resources.

The Master of Science and Doctor of Philosophy in Civil Engineering may be attained by qualified students who satisfy the requirements of the department and the Graduate College. Progress toward an advanced degree is measured by the accumulation of units of credit in formal course work and by evidence of intellectual growth and achievement. The prerequisite for graduate work is the equivalent of the undergraduate courses required for the Bachelor of Science in Civil Engineering, or other degree work which meets with the approval of the department.

The Master of Science and Doctor of Philosophy are offered in Sanitary Engineering. The prerequisite for admission to the first year of graduate study is a Bachelor of Science in Engineering or in one of the physical or life sciences.

Admission to the Graduate College with full status in civil or sanitary engineering is granted to graduates of institutions whose requirements for the bachelor's degree are substantially equivalent to those of the University of Illinois, provided the applicant's preparation is appropriate to advanced study in his chosen major field and his scholastic average is at least 4.0. Under certain conditions, applicants with a grade-point average of less than 4.0, and applicants from schools with different grading systems, may be considered if their average is equivalent to or higher than 3.75 and evidence is submitted indicating that the applicant's ability is not appropriately measured by the grades submitted.

Because of the wide range of interests in graduate work in the Department of Civil Engineering, there are no specific course prerequisites for a major in the department. The requirements for a major or minor must be approved by the head of the department. A minimum of eight units must be completed for the master's degree when a thesis is included. If a thesis is not included, nine units are required.

The department is presently engaged in a substantial building program which will reach completion in several phases. The new laboratories have extensive facilities for the study of the fundamental behavior of structures and structural materials under static or dynamic, and repeated loads, for the study of various

environmental conditions found in the sanitary engineering and sanitary science fields. Facilities now being completed provide for additional structural research areas, hydrology and hydraulics laboratories, computer facilities, and office space.

A pamphlet entitled *Graduate Study and Research in Civil and Sanitary Engineering* is available upon request to the head of the Department of Civil Engineering.

GRADUATE FACULTY

Professors: N. M. Newmark (Head of Department), W. C. Ackermann, A. H-S. Ang, J. E. Baerwald, J. W. Briscoe, A. B. Chilton, V. T. Chow, E. Danner, D. U. Deere, D. C. Drucker (Dean of College of Engineering), R. S. Engelbrecht, R. A. Eubanks, B. B. Ewing, S. J. Fenves, E. H. Gaylord, W. J. Hall, J. D. Haltiwanger (Associate Head of Department), W. W. Hay, M. Herrin, H. K. Hilsdorf, H. O. Ireland, H. M. Karara, C. E. Kesler, N. Khachaturian, T. E. Larson, W. H. Munse, R. E. Olson, J. E. Pearson, R. B. Peck, A. F. Richards, A. R. Robinson, M. O. Schmidt, W. C. Schnobrich, L. R. Schaffer, C. P. Siess, G. K. Sinnamon, M. A. Sozen, J. E. Stallmeyer, T. H. Thornburn, R. W. Woodhead.

Associate Professors: J. H. Austin, E. J. Barenberg, C. L. Chen, M. T. Davisson, R. I. Dick, G. R. Gurfinkel, A. J. Hendron, Jr., T. K. Liu, V. J. McDonald, J. W. Melin, R. J. Mosborg, N. N. Nielsen, J. T. O'Connor, J. T. Pfeffer, M. R. Thompson, W. H. Walker, R. N. Wright.

Assistant Professors: M. Ali-Akbarian, M. Amin, F. C. Birkemoe, L. T. Boyer, D. M. Brown, E. J. Cording, A. P. Froemming, W. L. Gamble, E. R. Holley, Jr., S. M. Holzer, F. V. Lawrence, Jr., L. A. Lopez, C. R. Marek, W. H. C. Maxwell, D. D. Meredith, B. Mohraz, E. L. Murphree, Jr., S. L. Paul, J. B. Radziminski, C. C. Tung, J. R. Weggel, Jr., H. G. Wenzel, Jr., K. W. Wong, B. C. Yen.

COURSES FOR GRADUATES

403. Analogue Photogrammetry, I. Study of the fundamental concepts of the analogue approach in photogrammetry; characteristics, capabilities, and limitations of analogue photogrammetric data reduction systems; theory of errors of interior and exterior orientation, methods of relative and absolute orientation; model deformations; critical surfaces. 1 unit. Prerequisite: Civil Engineering 203 or consent of instructor.

404. Analogue Photogrammetry, II. Two- and three-dimensional aerotriangulation, auxiliary data; propagation of errors; strip and block adjustment; design criteria for aerotriangulation projects. 1 unit. Prerequisite: Civil Engineering 403 or consent of instructor.

405. Analytical Aerotriangulation. Iterative and simultaneous rigorous block adjustment methods, numerical methods for the solution of large systems of equations; characteristics of various analytical photogrammetric systems. 1 unit. Prerequisite: Civil Engineering 304 or consent of instructor.

416. Design of Construction and Industrial Operations, I. Same as Industrial Engineering 416. Conceptual development of a systems design procedure for optimal design of construction and industrial operations; general forms required for critical path networks, linear programs, theory of queues and inventory models required for systems design; design evaluation and control models. 1 unit. Prerequisite: Bachelor of Science in civil or industrial engineering, credit or registration in Mathematics 363, or consent of instructor.

417. **Design of Construction and Industrial Operations, II.** Same as Industrial Engineering 417. Continuation of Civil Engineering 416. 1 unit. Prerequisite: Civil Engineering or Industrial Engineering 416; credit or registration in Mathematics 315; or consent of instructor.

420. **Pavement Design, I.** Analysis and methods of measurement of surface properties related to vehicle performance; factors affecting pavement durability; traffic wear, climate, chemical action, combined effects; composition design of flexible and rigid pavements for proper surface properties, load carrying capacity, wear resistance, stability, and durability. 1 unit. Prerequisite: Civil Engineering 220 or equivalent.

421. **Pavement Design, II.** Structural design of flexible and rigid pavements; loading characteristics, static, impact and repeated loads; load distribution through pavement layers, factors affecting distribution, methods of analysis; evaluation of subgrade support; criteria for selecting design values. 1 unit. Prerequisite: Civil Engineering 220 or equivalent.

422. **Fundamental Properties and Behavior of Bituminous Mixtures.** Composition and theories of physical structure of bitumens; rheological, failure, durability, and adhesive properties of bitumens and bituminous mixtures; analysis of factors influencing the performance of bituminous aggregate mixtures. 1 unit. Prerequisite: Civil Engineering 321 or consent of instructor.

423. **Highway Materials Stabilization.** Stabilization of aggregates and soils with cement, lime, bituminous materials, and other stabilizing agents; basic stabilization reactions, properties of stabilized materials, and composition design are emphasized. 1 unit. Prerequisite: Civil Engineering 220 or consent of instructor.

426. **Traffic Planning.** Traffic engineering planning functions; urban and rural master traffic plans; traffic analyses for new or existing streets, highways, and terminal facilities. 1 unit. Prerequisite: Civil Engineering 325 or equivalent.

427. **Geometric Highway Design.** Highway classification; highway capacity; highway design controls; sight distance; horizontal and vertical alignment; cross section elements; highway types; controlled access highways; design of at-grade of intersections, grade separations, and interchanges. 1 unit. Prerequisite: Civil Engineering 325 and 426, or consent of instructor.

428. **Traffic Engineering Operations.** Theory of traffic control; laws and ordinances; design and application of traffic control devices; special street designations; parking design and control; street illumination; miscellaneous traffic control designs. 1 unit. Prerequisite: Civil Engineering 325 and 426, or equivalent.

435. **Railway Construction and Maintenance.** Roadbed load capacity; economic design of track; advanced geometric design; economics of maintenance; grade crossing separations; review of specific projects. 1 unit. Prerequisite: Civil Engineering 335.

436. **Railroad Location and Operation.** Track and traffic capacity; optimum train size, performance, and scheduling; validity and accuracy of current practices; regional operating factors; optimum size of plant and modern location. 1 unit. Prerequisite: Civil Engineering 336 or consent of instructor.

440. **Theory of Water Treatment.** Properties of water and criteria of water quality; gas transfer operations in water treatment; chemical treatment processes; corrosion and corrosion control; sedimentation; filtration; disinfection; control of aquatic growths; control of tastes and odors. 1 unit. Prerequisite: Chemistry 122; Microbiology 101.

441. **Analysis and Treatment of Water and Waste Water.** Physical, biological, and chemical analysis of water and waste water; field sampling techniques; removal

of objectionable impurities, principles of disinfection; determination of dissolved oxygen, biochemical oxygen demand, and chemical oxygen demand; nitrogen, sulfur, and phosphorous compounds in waste waters. 1 unit. Prerequisite: Credit or registration in Civil Engineering 440.

442. Theory of Waste-Water Treatment. Composition, properties, and analysis of wastes; microbiology of waste treatment; pollution of natural waters; sedimentation; chemical treatment; aerobic and anaerobic treatment processes; disposal of waste sludges. 1 unit. Prerequisite: Civil Engineering 346; Chemistry 122; Microbiology 101.

443. Advanced Sanitary Engineering Laboratory. Experimental and pilot plant studies of the operational characteristics for various physical, chemical, and biological unit operations and processes used in the treatment of water and waste water. 1 unit. Prerequisite: Civil Engineering 441; credit or registration in Civil Engineering 442.

444. Industrial Water and Wastes Treatment. The theory and application of unit operations unique to the treatment of industrial water and wastes; advanced consideration of industrial waste problems of major industries; techniques of saline water conversions. 1 unit. Prerequisite: Credit or registration in Civil Engineering 440 and 442, or consent of instructor.

445. Water Quality and Pollution. Water quality standards and criteria for various beneficial uses; transport mechanisms for pollution in surface streams and ground water; fate of pollution and pollution control. 1 unit. Prerequisite: Civil Engineering 250 and 251; Mathematics 345.

446. Design of Water and Waste Treatment Plants. A study of the fundamental factors affecting choice of treatment units and combination of unit processes into an integrated plant. 1 unit. Prerequisite: Civil Engineering 440, credit or registration in Civil Engineering 442, or consent of instructor.

447. Radioactive Waste Disposal. Same as Nuclear Engineering 447. Sources and characteristics of radioactive wastes; methods of treatment; ultimate disposal; fate of radioisotopes in the environment; permissible levels in air and water; current levels in water supplies; water treatment methods; monitoring techniques; solid waste disposal; gaseous wastes disposal; air-monitoring; and reactor site selection and hazards evaluation. ½ or 1 unit. Prerequisite: Physics 282, or Chemistry or Nuclear Engineering 398, or consent of instructor.

448. Control of Air Pollution. A study of air contaminants from all types of sources; deleterious effects of contaminants on plants, animals, and materials; determination of source strength; basic theory of control devices; air pollution surveys; and organization of control programs. 1 unit. Prerequisite: General Engineering 360.

449. Analysis of Air Pollutants. Laboratory analysis of common air pollutants; theory of operation of laboratory and automatic field instrumentation. ½ to 1 unit. Prerequisite: Credit or registration in Civil Engineering 448.

450. Advanced Hydrologic Analysis and Design. Hydrologic cycle; hydrometeorology; collection of data; hyetograph and hydrograph analyses; infiltration and evapotranspiration studies; groundwater exploration and recharge; statistical analyses; determination of waterway areas; flood routing; river and reservoir regulations; design and planning of flood control projects; and modern development such as radar weather, radioactive tracers, disposal of nuclear wastes, and electronic analogs. 1 unit. Prerequisite: Bachelor of Science in civil engineering or consent of instructor.

452. Water Resources. An advanced interdisciplinary course on water resources planning and development; geographic aspects; data collection; governmental

functions; hydrologic implications; river hydraulics; hydraulic physical units and water quality; economic aspects; legal, political, and social problems; case studies. 1 unit. Prerequisite: Consent of instructor.

457. **Ground Water.** An advanced interdisciplinary course on ground water; hydrogeology; hydrodynamics of flow through porous media; ground water hydrology; hydraulics of wells; hydraulic analysis of seepage; ground water pollution; ground water resources. 1 unit. Prerequisite: Consent of instructor.

458. **Open-Channel Hydraulics.** Basic hydromechanics; flow types; channel characteristics; flow-profile computations; hydraulic jump analysis; design of nonerodible, erodible, and grassed channels and transitional structures; study of supercritical flow and unsteady flow; modern developments in theory and design practice; application of numerical method, method of characteristics, method of singular point, and electronic digital computers and analogs. 1 unit. Prerequisite: Bachelor of Science in civil engineering or consent of instructor.

461. **Matrix Formulation of Structural Analysis.** Development of structural analysis algorithms in matrix formulation: force and displacement vectors and transformations, element property matrices, representation of structures as assemblages of elements, displacement and force methods of analysis, selected advanced topics. 1 unit. Prerequisite: Civil Engineering 361 or equivalent.

463. **Optimization of Structures.** Structual design processes; formulation of problems in the optimization of structures; optimization of structural elements; minimum volume principles; use of mathematical programming in optimization of structural systems. 1 unit. Prerequisite: Consent of instructor.

465. **Structural Design in Metals.** Theories of behavior of structural metal members and their components; interpretation of codes and specifications for the design of bridges and buildings. This course and Civil Engineering 475 form a unit in the study of theoretical and experimental investigations. 1 unit. Prerequisite: Bachelor of Science in engineering with courses in structures.

467. **Behavior of Reinforced Concrete Structures.** Ultimate strength and behavior of statically indeterminate reinforced concrete structures; applicability of elastic analysis to framed structures; analysis and design of floor slabs in buildings. 1 unit. Prerequisite: Civil Engineering 366.

469. **Thin Shell Structures.** Fundamental membrane and bending theories of shells; application of theories to analysis and design of folded plates and cylindrical, rotational, and translational shells; membrane stresses and deflections; and approximate bending solutions by variational, finite-difference, and finite-element methods. 1 unit. Prerequisite: Civil Engineering 473 or consent of instructor.

470. **Structural Safety and Reliability.** Development of concepts and methods of probabilistic structural mechanics relevant to the analysis of structural safety and reliability. Concepts of probability and stochastic processes; statistical consideration of loads and structural resistances; engineering significance of statistical extremes; factor of safety and failure probability; prediction of system reliability; design for safety against natural destructive forces including wind and earthquakes. 1 unit. Prerequisite: Consent of instructor.

471. **Numerical and Approximate Methods of Structural Analysis.** Methods of successive approximations and numerical procedures for the solution of complex problems with applications to bridges, buildings, and aircraft structures: influence lines, moments and deflections of beams with axial load, buckling strength of columns, moments and deflections of beams resting on elastic or plastic supports, vibration of beams, analysis of arches, moments, and deflections of plates; other problems. 1 to 2 units.

472. Advanced Numerical Methods in Engineering. Basic concepts in numerical and approximate methods: successive approximations, relaxation, finite differences, ordinary boundary value problems, initial value problems, partial differential equations, characteristic value problems, methods of interpolation, variational procedures. Special study of selected topics including vibrations of complex structures; blast, impact, and earthquake effects on structures; buckling and flexure of frameworks; torsion of solid and thin-walled sections; lateral buckling of beams; bending and buckling of plates and of stiffened plates; plane stress and axially symmetric problems in elasticity; other topics. 1 to 2 units. Prerequisite: Civil Engineering 471.

473. Analysis and Design of Plates and Shells. Fundamental theories of bending and buckling of plates; practical application of theories in analysis and design of reinforced concrete bridge and building floors, highways and airport pavements, and structural plate components in metal; theory of shells with application to tanks, pressure vessels, shell roofs, and hipped plate constructure. 1 to 2 units. Prerequisite: Consent of instructor.

474. Dynamics of Framed Structures. Advanced treatment of the dynamics of multi-degree of freedom framed structural systems; fundamental concepts of eigenvalue theory of real matrices and energy principles of dynamics as bases for a unified approach to dynamical problems of structural assemblages; structural idealizations, principles of dynamics, Lagrange's equations, response calculations, normal mode method and its limitations, transfer matrix approach, computer utilization. 1 unit. Prerequisite: Civil Engineering 361, 374, or equivalent.

475. Behavior of Steel Structures. A critical evaluation of the actual behavior of metals, connections, members, and structures; the significance of this behavior in terms of design and the development of design specifications. This course and Civil Engineering 465 form a unit in the study of theoretical and experimental investigations. 1 unit. Prerequisite: Graduate standing in civil engineering or theoretical and applied mechanics.

476. Plastic Analysis and Design. Inelastic behavior of metal structural frameworks; concept of the plastic hinge; collapse configurations; analysis of collapse mechanisms; requirements for stability; deflections, incremental collapse, shakedown; connections; optimum design; grid frameworks. 1 unit. Prerequisite: Civil Engineering 465 or consent of instructor.

477. Design of Structures for Dynamic Loads. Nature of dynamic loading from earthquakes and bomb blasts; nature of dynamic resistance of structural elements and complete structures; concepts of limit design; review of methods of analysis; significance and interpretation of results of analyses; criteria for design of blast-resistant structures; critera for design of earthquake-resistant structures; application to actual problems. 1 unit. Prerequisite: Civil Engineering 374 or consent of instructor.

478. Discrete Methods of Solid and Structural Mechanics. Concepts and methods for the discrete formulation and solution of structural and solid mechanics problems. Discrete idealization of solid media and structures by lumped-parameter and finite element approaches; stress analysis and wave propagation in plane and axi-symmetric solids; analyses of plate and shell structures; inelasticity and non-linearity; special boundary conditions; special problems, including soil and rock mechanics problems, and structure-medium interaction. 1 unit. Prerequisite: Civil Engineering 379, Aeronautical and Astronautical Engineering 326 or Theoretical and Applied Mechanics 351 or equivalent, and registration in Computer Science 400 or equivalent; or consent of instructor.

480. Earth Pressures and Retaining Structures. Classical and modern earth pressure theories and their experimental justification; pressures and bases for design of

retaining walls, bracing of open cuts, anchored bulkheads, cofferdams, tunnels, and culverts. 1 unit. Prerequisite: Credit or registration in Civil Engineering 384.

481. Earth Dams and Related Problems. Fundamentals of problems of slope stability; seepage in composite sections and anisotropic materials; methods of stability analysis; mechanism of failure of natural and artificial slopes; compaction; field observations. 1 unit. Prerequisite: Credit or registration in Civil Engineering 384, or consent of instructor.

482. Advanced Soil Mechanics, I. Theoretical and experimental studies in soil mechanics, stress distribution in homogeneous and stratified soils, theory of consolidation for multidirectional flow and time dependent loading, numerical methods, secondary consolidation, settlement analysis, experimental measurements. 1 unit. Prerequisite: Civil Engineering 383.

483. Advanced Soil Mechanics, II. Theoretical and experimental studies in soil mechanics, shearing properties of saturated soils, physical properties of partially saturated soils, physicochemical properties of clays, laboratory direct shear and triaxial shear testing. 1 unit. Prerequisite: Civil Engineering 383.

484. Foundation Engineering. Critical study of case histories of projects in foundation engineering; current procedure for design and construction of foundations, embankments, and waterfront structures. 1 unit. Prerequisite: Civil Engineering 384.

485. Soil Engineering for Transportation Facilities. Problems of soil classification; evaluation of stability of natural and compacted soils as subgrades, slopes, and embankments; effect of climate, soil properties, compaction, and admixtures on subgrade stability. 1 unit. Prerequisite: Civil Engineering 383 or equivalent.

494. Municipal Administration and Engineering. Legal authority of muncipalities, forms of municipal government; municipal functions, organization, and management; city finance; engineering functions of city government; city planning and zoning; building codes and inspection; street lighting; public utilities; city cleaning; recreational development. 1 unit. Prerequisite: Bachelor of Science in civil engineering or consent of instructor.

495. Civil and Sanitary Engineering Seminar. Discussion of current topics in civil and sanitary engineering and related fields by staff, students, and visiting lecturers. Course may be repeated. 0 or ¼ unit.

497. Special Problems. Individual investigations or studies of any phase of civil engineering selected by the student and approved by his adviser and the staff member who will supervise the investigation. 0 to 4 units. Prerequisite: Consent of instructor.

499. Thesis Research. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Advanced Surveying. Precise horizontal and vertical control surveys; state plane coordinate systems; special construction surveys. ½ unit. Prerequisite: Civil Engineering 202 or consent of instructor.

304. Fundamentals of Analytical Photogrammetry. An introduction to the basic principles, procedures, and methods of analytical photogrammetry, including relative and absolute orientation, and strip and block adjustment. ¾ or 1 unit. Prerequisite: Civil Engineering 203 and 306, or consent of instructor.

305. Observational Astronomy. Same as Astronomy 314. Astronomical coordinate systems and transformations; theory of, and practice in, approximate and

precise determinations of latitude, longitude, and time; introduction to theory of errors; theory and practice of astronomical photography. 1 unit. Prerequisite: Astronomy 102 or 210, or Civil Engineering 201; Mathematics 142 or 143.

306. **Adjustment of Observations.** A study of the methods of least squares and its application to the adjustment of photogrammetric and geodetic problems; formation and solution of the normal equations, including the use of matrix algebra; types of adjustments including adjustments for hybrid systems; discussion of the normal distribution and the statistical foundations of the method of least squares. ¾ or 1 unit. Prerequisite: Mathematics 315 and Civil Engineering 202, or consent of instructor.

307. **Photogrammetric Engineering.** A study of metrical photography in civil engineering practice, analytical and analogue photogrammetric systems, photometrics and outer space mapping techniques, and automated photographic mapping systems. ¾ or 1 unit. Prerequisite: Civil Engineering 203 or consent of instructor.

314. **Fundamentals of Systems Approach.** Introduction to the application of linear programming, network theory, and queueing theory to the synthesis of civil engineering systems. ½ or 1 unit. Prerequisite: Civil Engineering 215; Mathematics 263 or consent of instructor.

315. **Construction Productivity.** Introduction to the application of scientific principles to the measurement of, and the forecasting of, productivity in construction engineering; conceptual and mathematical formulations of the labor, equipment, and material factors affecting productivity. ½ or 1 unit. Prerequisite: Civil Engineering 215; credit or registration in Mathematics 263 or equivalent; or consent of instructor.

316. **Construction Planning.** Introduction to the application of scientific principles to the normative planning of construction operations. ½ or 1 unit. Prerequisite: Civil Engineering 315 or consent of instructor.

318. **Construction Cost Analyses and Estimates.** Introduction to the application of scientific principles to costs and estimates of costs in construction engineering; concepts of and statistical measurements of the factors involved in direct costs, general overhead costs, cost mark-ups and profits; the fundamentals of cost recording for construction cost accounts and cost controls. ½ or 1 unit. Prerequisite: Civil Engineering 315 or consent of instructor.

321. **Bituminous Materials and Mix Design.** Properties and control testing of bituminous materials; analysis of bituminous paving mixtures; composition and design of asphaltic concrete and soil-asphalt mixes. ½ unit. Prerequisite: Civil Engineering 214 and 220, or consent of instructor.

322. **Development of Highway Facilities.** Analysis of factors in developing a highway transportation facility; traffic estimates and assignment; problems of highway geometrics and design standards; planning and location principles; intersection design factors; street systems and terminal facilities; programming improvements; drainage design; structural design of surface; concepts of highway management and finance; highway maintenance planning. 1 unit. Prerequisite: Civil Engineering 220 or consent of instructor.

325. **Highway Traffic Characteristics.** Vehicle operating characteristics; driver characteristics; pedestrian characteristics; roadway characteristics, individually and collectively as traffic stream characteristics, are related to the planning, design, and operation of highway facilities. ½ unit. Prerequisite: Civil Engineering 220 or consent of instructor.

333. **Urban and Regional Transportation.** Importance of transportation and its relation to urban and regional planning; characteristics of transport systems;

transportation planning including surveys, data analysis, and problems of administration and finance; coordination and integration of transport. ½ or 1 unit. Prerequisite: Consent of instructor.

334. **Airport Design.** Basic principles of site selection for airports and fundamental considerations of design, construction, and maintenance of airport pavements and structures. ½ or 1 unit. Prerequisite: Civil Engineering 220 and senior standing in civil engineering, or consent of instructor.

335. **Railway Construction and Maintenance.** Loads and load distribution on track and subgrade; roadbed construction and stabilization; track stresses, design, and materials; turnouts and crossings; maintenance programs. ½ or 1 unit. Prerequisite: Consent of instructor; credit or registration in Civil Engineering 230 for those with a minor in railroad or transportation engineering.

336. **Railway Location and Operation.** Influence of traffic, alignment, distance, gradients, and motive power upon operating expenses; mechanics of train operation; economic design of location. ½ or 1 unit. Prerequisite: Consent of instructor; credit or registration in Civil Engineering 230 for those with a minor in railroad or transportation engineering.

337. **Signals.** Train movements; systems of signals; track circuits; track capacity; interlockings; economics of signaling. ½ or 1 unit. Prerequisite: Consent of instructor; credit or registration in Civil Engineering 230 for those with a minor in railroad or transportation engineering.

338. **Terminals.** Design and operation of freight terminal facilities for rail, highway, air, and water carriers; passenger terminals; special terminal requirements for specific commodity categories; coordination. ½ or 1 unit. Prerequisite: Consent of instructor; credit or registration in Civil Engineering 230 for those with a minor in railroad or transportation engineering.

345. **Environmental Health Engineering.** The application of engineering principles to the control of environmental sanitation and communicable disease control, including administration, biostatistics, epidemiology, vector control, pesticides, milk and food sanitation, swimming pools, individual water supply and wastewater disposal, plumbing, refuse collection and disposal, industrial hygiene and air pollution, radiological health and international health. ¾ unit. Prerequisite: Consent of instructor.

346. **Biology of Polluted Water.** The significance of biology in water quality, stream pollution, and waste treatment. ½ unit. Prerequisite: Consent of instructor.

349. **Fundamentals of Radiation Protection.** Same as Nuclear Engineering 349. Principles and practice of health physics and radiation protection engineering, including such topics as: principles of dosimetry; sources of ionizing radiation; determination of radiation tolerances; dosimetric instruments; standards and regulations. ¾ or 1 unit. Prerequisite: Credit or registration in Nuclear Engineering 397 or Physics 382, or equivalent.

351. **Hydromechanics.** Applied fluid mechanics with particular reference to topics in hydraulic design, analysis, and research in civil engineering areas; covers dimensional analysis and dynamic similarity, analysis of potential flow, boundary-layer problems, turbulence, and diffusion; hydraulic transients, water waves, transport phenomena. ¾ unit. Prerequisite: Theoretical and Applied Mechanics 235; Civil Engineering 251.

352. **Water Resources Design.** Study and evaluation of phases of river mechanics; water resources history and project implementation; development of a water resources project plan. ¾ unit. Prerequisite: Civil Engineering 250; Theoretical and Applied Mechanics 235.

353. **Hydraulic Structures.** Introduction to the design of hydraulic structures, including consideration of types and function of dams; hydrologic design; hydraulic design of spillways and outlet works; determination of loads and stresses for concrete structures; seepage, piping, and stability of earth structures. ¾ unit. Prerequisite: Civil Engineering 250 and 251.

354. **Hydraulic Engineering Laboratory.** Fundamental principles, operation, and use of model laboratories; dimensional analysis; hydraulic similitude; theory and design of hydraulic models as applied to a specific laboratory problem. ¾ unit. Prerequisite: Theoretical and Applied Mechanics 235.

356. **Hydraulics of Surface Drainage.** Application of hydraulic and hydrologic principles; elements of channel design, hydrologic determination of design flow; flow through bridge openings and other obstacles; hydraulics of drainage areas; overland flow; runoff from highways; runways and urbanized areas; hydraulics of storm-drain systems; culvert design. ¾ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 235; Civil Engineering 250 or consent of instructor.

361. **Advanced Structural Analysis.** A unified development of force and displacement analysis methods for linearly elastic framed structures including introduction to matrix methods of formulation; applications to plane and space frames and trusses; computer use. ¾ or 1 unit. Prerequisite: Civil Engineering 262 or equivalent.

363. **Behavior and Design of Metal Structures, II.** Members under combined loads; welded, riveted, and bolted connections; moment-resistance connections; plastic design. ¾ or 1 unit. Prerequisite: Civil Engineering 263 or consent of instructor.

364. **Reinforced Concrete Design, II.** Limit design of continuous reinforced concrete members and slabs of various types. ¾ or 1 unit. Prerequisite: Civil Engineering 264; credit or registration in Civil Engineering 262.

366. **Behavior of Reinforced Concrete Members.** Ultimate strength and behavior of reinforced concrete members and relation between results of research and current specifications for design; members subjected to flexure, axial compression, combined flexure and axial load, combined flexure and shear, and bond. 1 unit. Prerequisite: Bachelor of Science in civil engineering or architecture with courses in structures and reinforced concrete design.

368. **Prestressed Concrete.** Principles and methods of linear prestressing; behavior, strength, and design of noncomposite simple beams, composite simple beams, and continuous beams; time-dependent variables and long-time deflections. ¾ or 1 unit. Prerequisite: Civil Engineering 262 and 264.

369. **Behavior and Design of Wood Structures.** Theory and practice in design of modern wood structures; effect of plant origin and physical structure of wood on its mechanical strength; fasteners and their significance in design and the development of design formulae. ¾ or 1 unit. Prerequisite: Civil Engineering 261 or equivalent, or consent of instructor.

374. **Introduction to Structural Dynamics.** Analysis of the dynamic response of structures and structural components to transient loads and foundation excitation; single-degree-of-freedom and multidegree-of-freedom systems; response spectrum concepts; simple inelastic structural systems; introduction to systems with distributed mass and flexibility. Credit is not given for both Civil Engineering 374 and Theoretical and Applied Mechanics 311. ¾ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 212; Mathematics 345; Civil Engineering 261; or equivalent.

379. **Applied Structural Mechanics.** Study of beams under lateral load; beams with combined lateral load and thrust; buckling; beams on elastic foundations;

applications of Fourier series and virtual work principles to beam-type structures; stress and strain in three dimensions; applications to flexure of beams and plates and to constrained torsion; elements of the engineering theory of plates. ¾ or 1 unit. Prerequisite: Mathematics 345 and one undergraduate course in statically indeterminate structures, or consent of instructor.

383. **Soil Mechanics.** Identification, description, and classification of soils; index properties, weight-volume relationships; hydraulic properties; stress-deformation characteristics; ultimate strength; subsurface exploration; character of natural soil deposits. ¾ or 1 unit. Prerequisite: Consent of instructor.

384. **Applied Soil Mechanics.** Application of soil mechanics to foundations of buildings; stability of earth slopes; earth pressure and retaining walls; braced cuts; damage due to construction operations. ¾ or 1 unit. Prerequisite: Civil Engineering 383 or consent of instructor.

385. **Engineering Aspects of Surficial Soils.** Use of geologic and pedologic information and airphoto interpretation techniques in the prediction of engineering properties of soils and the planning of engineering soil surveys. Field trip; estimated expense, $5.00. 1 unit. Prerequisite: Civil Engineering 210 or consent of instructor.

391. **Computer Methods in Civil Engineering.** Review of programming concepts; formulation and programming of numerical, data-processing, and logical problems with applications to various branches of civil engineering; organization of programs and data; development and use of problem-oriented programming languages in civil engineering. ½ or 1 unit. Additional work required for more than ½ unit of credit. Prerequisite: Computer Science 101 or equivalent; senior or graduate standing in the Department of Civil Engineering or consent of instructor.

THE CLASSICS

(Including Classical Civilization, Greek, and Latin)

The Department of Classics offers graduate work leading to the Master of Arts and Doctor of Philosophy.

The Master of Arts may be taken in Latin, in Greek, in the Classics, or in the Teaching of Latin. For the Master of Arts in the Classics, the major may be either Latin or Greek, with the other language offered as a minor. No master's thesis is required; extra units of work in Greek or Latin are substituted for the thesis.

The Doctor of Philosophy is given in Classical Philology. Major work may be taken in either Latin or Greek, but whichever language is taken as a major, the other one must be taken either as the sole minor or as a first minor.

The minimum grade-point average for admission to graduate study in the department is 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis. All graduate students should take Greek or Latin 495-496, Bibliography and Criticism, during their first year of graduate study. Other regulations of the department governing graduate studies are described in a departmental brochure which may be obtained by writing to the Head of the Department, 361 Lincoln Hall.

Regular examinations in the written translation of selected passages of Greek and Latin are arranged at the beginning of each semester. Candidates for the master's degree are required to take one examination in their major language in each semester of residence. Candidates for the doctorate are required to take both examinations until the preliminary examination has been passed. Students who receive two successive grades of A are exempt from further examinations in that language. Students who fail to obtain a satisfactory grade (B) will not be admitted to the preliminary examination.

GRADUATE FACULTY

Professors: J. J. Bateman (Head of Department), J. L. Heller, R. P. Oliver, L. Wallach.
Associate Professors: M. Naoumides, R. T. Scanlan.
Assistant Professors: H. Jacobson.

Classical Civilization

The following courses presuppose no knowledge of the Greek or Latin language and are open to all students. For other courses in the area of classical civilization, see Art 304, 305, 306, 307, and 454; History 381, 382, 383, 384, 411, and 413; Philosophy 303, 309, 310, and 401; and Speech 411 and 412.

COURSES FOR GRADUATES

445. Field Work in Classical Archaeology. Participation in archaeological excavation; methods and procedures are discussed and practiced in actual working conditions. 1 unit. Prerequisite: Consent of instructor.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Greek Literature in Translation. An introduction to Greek literature from Homer to the Hellenistic age and to its cultural and historical background. ½ unit. Prerequisite: Consent of instructor. Naoumides.

302. Latin Literature in Translation. All introduction to Latin literature of the classical period and to its cultural and historical background. ½ unit. Prerequisite: Consent of instructor.

361. The Archaeology of Greece. Monuments and material remains illustrating the development of Greek civilization to 323 B.C. ½ unit. Prerequisite: A course in ancient history, art, or language, or consent of instructor. Allen.

362. The Archaeology of Italy. Monuments and material remains illustrating the development of Graeco-Roman and other ancient Italian civilizations to 303 A.D. ½ unit. Prerequisite: A course in ancient history, art, or language, or consent of instructor. Allen.

Greek

Preparation for first-year graduate work in Greek should include at least three years of college Greek, or equivalent, and two years of college Latin. A reading knowledge of German and French is important for candidates in this subject. The study of history and philosophy is especially recommended.

COURSES FOR GRADUATES

In any given semester, a selection from the following courses is offered. Consult the departmental office, 361 Lincoln Hall, well in advance of registration.

Unless otherwise noted, the prerequisite to all courses is three years of college Greek.

409. Greek Versification. Greek prosody; survey of meters, lines, and cola in epic, lyric, and dramatic poetry; lyric meters of Greek drama. 1 unit.

411. Hellenistic Literature. 1 unit. Bateman.

412. **Lucian and His Age.** 1 unit.

413. **Greek Lyric Poetry.** 1 unit. NAOUMIDES.

414. **Pindar.** 1 unit. NAOUMIDES.

415. **Homer.** 1 unit.

416. **Thucydides.** 1 unit. NAOUMIDES.

417. **Bacchylides.** 1 unit. NAOUMIDES.

422. **Sophocles.** 1 unit.

423. **Aeschylus.** 1 unit.

424. **Euripides.** 1 unit.

425. **Greek Drama: Comedy.** 1 unit.

491. **Directed Reading.** ¼ to 1 unit; no student may offer more than 1 unit of credit in this course toward the Ph.D. degree. Prerequisite: Second-year graduate standing.

495. **Bibliography and Criticism.** Same as Latin 495. Introduction to the methods and techniques of scholarship. ½ unit. OLIVER.

496. **Bibliography and Criticism.** Same as Latin 496. ½ unit. OLIVER.

499. **Thesis Research.** Guidance in writing theses for advanced degrees. 0 to 4 units. BATEMAN, HELLER, NAOUMIDES, OLIVER, WALLACH.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Third-Year Greek.** Readings in Attic prose. ½ unit. Prerequisite: Greek 202.

302. **Third-Year Greek.** Continuation of Greek 301. Readings in Greek Tragedy. ½ unit. Prerequisite: Greek 301.

308. **Comparative Grammar of Greek and Latin.** Same as Latin and Linguistics 308. An historical study of the Greek and Latin languages through use of the comparative method. ½ unit. Prerequisite: Latin 202 or equivalent; credit or registration in Greek 202. TAYLOR.

391. **Readings in Greek Literature.** Readings from Greek authors chosen by the instructor chiefly from the following list of authors and topics (others may be chosen): Herodotus, Tragedy, Comedy, Lyric Poetry, Aristotle, Oratory, New Testament, Survey of Greek Literature. ¾ unit. Prerequisite: Greek 302 or equivalent. STAFF.

Latin

Preparation for first-year graduate work in Latin should include at least two years of preparatory Latin and three years of college Latin. A reading knowledge of French and German is important. Some acquaintance with Greek is highly desirable, and the study of history and philosophy is especially recommended.

Candidates for the Master of Arts in the Teaching of Latin must earn four units in Latin, two units in education, and two units in electives. Three of the four required units in Latin must be in courses numbered above 400; the other unit is from Latin 305, 306, 311, 312, or 391. The required work in education consists of Educational Psychology 311 and 312 and one unit selected from History and Philosophy of Education 303, 304, 305. The electives may be in Latin, in Greek, in education, or, in exceptional cases, in other fields. The courses in Latin and the electives must be selected with the approval of the adviser, Professor J. J. Bateman, 361 Lincoln Hall. See pages 38 and 39.

COURSES FOR GRADUATES

In any given semester, a selection from the following courses is offered. Consult the departmental office, 361 Lincoln Hall, well in advance of registration.

Unless otherwise noted, the prerequisite to all courses is three years of college Latin or equivalent.

401. **Readings in Latin for Graduate Students.** Directed readings, largely in medieval and modern Latin. Designed for graduate students who need to use Latin in their research. No graduate credit. Prerequisite: Two years of high school Latin or equivalent.

402. **Teaching College Latin.** A course designed for new graduate teaching assistants in the Classics Department. New techniques are examined for teaching pronunciation, vocabulary, grammar, and the reading of Latin. Class is closely correlated with the teaching assignments of the graduate students. No credit.

409. **History of the Latin Language.** 1 unit. Prerequisite: Two years of college Latin or equivalent; two years of a modern foreign language.

410. **Vulgar Latin.** 1 unit. Prerequisite: Two years of college Latin; two years of a Romance language.

411. **Latin Epigraphy.** 1 unit. Prerequisite: Three years of college Latin or equivalent; one year of ancient history. OLIVER.

412. **Latin Elegy.** 1 unit. OLIVER.

413. **Caesar.** 1 unit. BATEMAN.

414. **Lucan.** 1 unit. OLIVER.

415. **Lucretius.** 1 unit.

416. **Vergil.** 1 unit. BATEMAN.

421. **Horace.** 1 unit.

422. **Plautus and Terence.** 1 unit.

423. **Latin Romance.** 1 unit.

425. **Cicero.** 1 unit. WALLACH, WOLVERTON.

426. **Tacitus.** The *Annales*. 1 unit. OLIVER.

427. **Roman Satire.** 1 unit. HELLER.

441. **Latin Paleography.** 1 unit. WALLACH.

460. **Bibliography and Criticism of Medieval Latin.** Introduction to research in Medieval and Patristic Latin. ¾ or 1 unit. Prerequisite: Latin 360, 361, or equivalent. WALLACH.

461. **The Medieval Latin Bible.** Study of the Vulgate and earlier Latin versions of the Bible and of the commentaries of the Latin Fathers. 1 unit. Prerequisite: Latin 360, 361, or equivalent. WALLACH.

462. **The Carolingian Renaissance.** Study of the Latin literature of the Carolingian period with emphasis on the work of Alcuin and Charlemagne. 1 unit. Prerequisite: Latin 360, 361, or equivalent. WALLACH.

491. **Directed Reading.** ¼ to 1 unit; no student may offer more than 1 unit of credit in this course toward the Ph.D. degree. Prerequisite: Second-year graduate standing.

495. **Bibliography and Criticism.** Same as Greek 495. Introduction to the methods and techniques of scholarship. ½ unit. OLIVER.

496. Bibliography and Criticism. Same as Greek 496. ½ unit. OLIVER.

499. Thesis Research. Guidance in writing theses for advanced degrees. 0 to 4 units. BATEMAN, HELLER, NAOUMIDES, OLIVER, WALLACH.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

305. Cicero and the Roman Republic. An advanced course in the writings of Cicero emphasizing the activities of the year 63 B.C., Cicero's consular year. Selected orations and letters of Cicero are read in Latin. Background reading on important figures and events of the late Republic in English. ½ unit. Prerequisite: Latin 201 and 202. SCANLAN.

306. An Advanced Course in Vergil. An advanced course in the poetry of Vergil emphasizing the ancient epic as a literary genre and the background study of Roman social, political, and literary history. Selections are read from the *Aeneid,* the *Georgics,* and the *Bucolics.* ½ unit. Prerequisite: Latin 201 and 202. SCANLAN.

308. Comparative Grammar of Greek and Latin. Same as Greek and Linguistics 308. An historical study of the Greek and Latin languages through use of the comparative method. ½ unit. Prerequisite: Latin 202 or equivalent; credit or registration in Greek 202. TAYLOR.

311. Advanced Latin Composition. Practice in the writing of Latin prose. ½ unit. Prerequisite: Twelve hours of Latin acceptable for a major.

312. Advanced Latin Composition. ½ unit. Prerequisite: Latin 311.

313. Oral Latin. Introduction to the use of Latin as a means of oral communication, with particular reference to instruction in secondary schools. S; ½ unit. Prerequisite: Latin 312 or consent of instructor.

360. Patristic Latin. Literary and historical texts in prose and poetry from Tertullian to Jerome and Augustine. ¾ or 1 unit. Prerequisite: Two years of college Latin or consent of instructor. WALLACH.

361. Medieval Latin. Literary and historical texts in prose and poetry from Cassiodorus to Roger Bacon. ¾ or 1 unit. Prerequisite: Two years of college Latin or consent of instructor. WALLACH.

391. Readings in Latin Literature. Readings from Latin authors chosen by the instructor chiefly from the following list of authors and topics (others may be chosen) : Livy, Horace, Vergil, Cicero's *Orations,* Seneca, Ovid, Cicero's *Essays,* Patristic Latin, Medieval Latin. ¾ unit. Prerequisite: Three years of college Latin or equivalent; consent of instructor. STAFF.

COMMUNICATIONS

Doctor of Philosophy in Communications. This program is administered by an interdepartmental committee in the College of Communications. It provides a core program in communications and permits advanced specialization in several areas: process, content, and effects of the mass media, including their political, social, and economic aspects; advertising; interpersonal communication; psycholinguistics.

The program applies the methods and disciplines of the social sciences, supported by the humanities, fine and applied arts, and natural sciences, to the basic problems of human communications. It is intended for students who plan careers in teaching communication subjects such as journalism, radio-television, and psycholinguistics; scholarly research on the development, control, and ethics of the

mass media; experimental research on public opinion measurement; advertising, communication effects, psycholinguistics, and semantics; executive jobs in government and industry requiring breadth, perspective, and a scholarly background.

Prerequisite to admission is a 4.0 grade average and a broad background in the social sciences and humanities. Many of the advanced courses have introductory courses as prerequisites. An introductory course in statistics is generally useful.

The program provides both an introduction to the broad field of communications with its related disciplines (requirements 1, 2, and 4, below), and specialization in a subfield (requirements 3 and 5). The student must meet these detailed requirements:

(1) Communications 471 and 472, Proseminar, two units.

(2) One unit selected from Group A (Communications 414, 432, 444, 462, 468, 470, 473, 474, 481, 483, 307, 308, 344, 360), and one unit from Group B (Communications 420, 424, 425, 426, 436, 456, 325, 351, 352, 370).

(3) An area of specialization in communications. The following are suggested areas: theory of communications, philosophy of communications, communications policies and structures, public opinion and attitude formation, advertising (illustrated by Group A above); interpersonal communication, psycholinguistics (illustrated by Group B above). Occasionally the Committee will approve other specializations. Two units must be taken in courses in research methods; such courses may deal with the philosophical, historical, mathematical, or technical aspects of inquiry and research. Courses for the area of specialization are not limited to courses cross-listed with communications. With his adviser's approval, a student may offer any relevant graduate course as part of the major.

(4) Either a sole minor of four units in a discipline other than communications, or a split minor with three units in a discipline other than communications and three units in a field of communications outside the area of concentration. (If the concentration is in Group A, the minor must be in Group B, and *vice versa*.) Courses cross-listed in communications may not be counted toward a minor in a discipline other than communications.

(5) Communications 499, Thesis Research, eight units.

(6) In some instances, when essential to the student's research program and required by the adviser, high proficiency in one foreign language or in a research skill.

(7) A preliminary written and oral examination.

(8) A final oral examination centered on but not restricted to the field of the dissertation.

Minor. A doctoral candidate wishing to minor in communications should select four, three, or two units (according to the requirements of his major department). Communications 471 and 472 are recommended as giving a broad survey of theory and research in this area. Candidates minoring in communications are expected to have a social science background for the courses they choose.

Further information may be obtained from the chairman of the administrative committee, Professor Theodore Peterson, 119d Gregory Hall.

GRADUATE FACULTY

Professors: T. Peterson (Chairman of Committee on Graduate Study in Communications), W. R. Ashby, J. B. Casagrande, S. W. Dunn, J. E. Hulett, J. W. Jensen, H. L. Mueller, C. E. Osgood, Rita J. Simon, N. Wedding.

Associate Professors: J. W. Carey, M. E. Fishbein, H. S. Maclay, J. H. Schacht, H. I. Schiller.

Assistant Professors: T. Guback, R. Pyszka, Nancy Wiggins.

COURSES FOR GRADUATES

414. Seminar on Social Interaction. Same as Sociology 414. An analysis of social interaction based on the social psychology of C. H. Cooley, G. H. Mead, and W. I. Thomas. Problems of theory, concepts, and method. 1 unit. Prerequisite: One unit of graduate credit in sociology. HULETT.

420. Seminar in Semantics. Same as Philosophy 420. Intensive study of important contemporary contributions in the fields of semantics, analytic philosophy, and the philosophy of language. May be repeated for credit. ¾ or 1 unit.

424. Linguistics and Communication. Same as Linguistics 424. The communicative function of language with emphasis on the application of linguistic theories and methods to problems in human communication. 1 unit. MACLAY.

425. Psycholinguistics. Same as Linguistics and Psychology 425. A critical survey of methods and theories in the psychological study of the communication process with emphasis upon linguistic, information-theory, and learning-theory approaches, psycholinguistic analysis of language decoding and encoding, and the development and measurement of symbolic processes, including meaning. 1 unit. Prerequisite: Consent of instructor. OSGOOD.

426. Research Seminar in Psycholinguistics. Same as Linguistics and Psychology 426. Critical discussion of research problems to which psycholinguistic theories and techniques can be applied. Students taking this course plan, execute, and report an original piece of research in this area. ½ or 1 unit. Prerequisite: Communications 425; consent of instructor. OSGOOD.

432. Books and Libraries Since the Renaissance. Same as Library Science 432. The development of printing since the fifteenth century and its effect on the nature and use of the book; the growth of national, college and university, public, and other libraries in Europe and America from the Renaissance to the present day. 1 unit. STEVENS.

436. Problems of Cybernetics. Same as Biophysics 436 and Electrical Engineering 474. The study of brain-like processes in complex dynamic systems with emphasis on unsolved problems, current developments, and opportunities for research. 1 unit. Prerequisite: Consent of instructor. ASHBY.

444. Seminar in Public Opinion. Same as Sociology 444. Development and theory of public opinion process in society; censorship, interest groups, and propaganda; mass media and public opinion. 1 unit. SIMON.

456. Psychology of Social Communication. Same as Psychology 456. Recent developments in method and theory of attitude change through communication; the nature and determinants of informal social communication; the effects of persuasive communications on public opinion; change in intergroup attitudes through communication. 1 unit. Prerequisite: Psychology 351 or equivalent, or consent of instructor. FISHBEIN.

462. Seminar in Radio and Television. Same as Radio-Television 462. A study of the performance of radio and television in terms of content, government and industry controls, social responsibility, economic bases, and psychological and social effects. 1 unit.

463. World Broadcasting. Same as Radio-Television 463. A study of the broadcast systems used by the nations of the world; alternative and "mixed" systems; international organizations, agreements, exchanges, and problems; broadcasts to and from other countries; implications of such new developments as satellites; mass and non-mass uses. 1 unit. Prerequisite: Radio-Television 462 or consent of instructor.

468. The Political Economy of Communications. Same as Journalism 468. Analysis of the structure, policy, and behavior of such media of communications as newspapers, magazines, books, postal service, telegraph, telephone, broadcasting, and film, with special emphasis on their relationships to political order and the economy. 1 unit. GUBACK.

470. Communications and Popular Culture. Same as Journalism 470. Problems of cultural analysis related to the media of communications; social implications of communications research. 1 unit. CAREY, GUBACK, SCHACHT.

471. Proseminar in Communications, I. Same as Journalism 471. A general discussion of the mass media of communications, their role as social institutions, their control and support; content, audience, and effect of the mass media. 1 unit. CAREY, STAFF.

472. Proseminar in Communications, II. Same as Journalism 472. A general discussion of the problem of communications, including the individual as a communicating system, symbolic processes, analysis of messages, psycholinguistics, and language as social behavior. 1 unit. MACLAY, STAFF.

473. History and Theory of Freedom of the Press. Same as Journalism 473. Development of the Anglo-American press system and the idea of freedom of the press; contemporary mass media and their implications for freedom and democracy. 1 unit. JENSEN.

474. Communications Systems. Same as Journalism 474. Analysis of the structure and development of communications systems; examination of the role of communication in social change, political movements, and formal organizations. 1 unit. CAREY, SCHILLER.

481. Advanced Advertising Principles. Same as Advertising 481. Emphasis is placed on determination and understanding of the principles as related to the science, philosophy, and art of advertising. Students may not receive graduate credit for both Communications 481 and Advertising 388. 1 unit. WEDDING.

482. Research Methods in Advertising and Communications. Same as Advertising 482. A treatment of basic research concepts and procedures in the social sciences with emphasis on advertising and communications. Both nonquantitative and quantitative methods are examined. 1 unit. DUNN, PYSZKA.

483. Advertising and the Mass Media. Same as Advertising 483. Functions of mass media as carriers of advertising messages; quantitative and qualitative audience research and analysis; formulation of media plans to achieve specific communications objectives. 1 unit.

490. Special Topics in Communications. ½ to 2 units. Prerequisite: Consent of chairman of Committee on Graduate Study in Communications. STAFF.

492. Research Methods in Communications. Same as Journalism 492. An introduction to the methods of empirical research in the behavioral sciences applicable to research problems in human communication, with emphasis on studies of mass communication. Lectures, readings, and laboratory practice. 1 unit. Prerequisite: An introductory statistics course or consent of instructor. WIGGINS.

499. Thesis Research. 0 to 4 units. Students may reregister for a total of eight units. Prerequisite: Consent of chairman of Committee on Graduate Study in Communications and of thesis supervisor. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

307. The Art of the Screen: Narration. Same as Speech 307. Critical study of the adaptation and synthesis of principles of drama, literature, the graphic arts,

and music in the evolution of the screen narrative. Lectures, discussions, and reports; viewing of selected films and television programs. ½ unit. Prerequisite: Training in critical approaches to literature, drama, art, or music; consent of instructor. MUELLER.

308. The Art of the Screen: Exposition and Persuasion. Same as Speech 308. Critical study of the application of the eclectic principles of the screen narrative to the transmission of information and the influencing of attitude, opinion, and action. Lectures, discussions, and reports; viewing of selected films and television programs. ½ unit. Prerequisite: Speech 307 or consent of instructor. The prerequisite does not apply to students of library science who have obtained the necessary background through independent reading. MUELLER.

325. Introduction to Psycholinguistics. Same as Linguistics 325. An introductory survey of psychological and linguistic approaches to the study of communication. 1 unit. Prerequisite: An introductory course in linguistics or psychology. MACLAY.

344. Public Opinion. Same as Sociology 344. Opinion changes and control; propaganda; interest groups and opinion; critical review of methods of measurement. ½ unit. Prerequisite: Sociology 100 or 151. SIMON.

351. Advanced Social Psychology. Same as Psychology and Sociology 351. An integrative treatment of individual behavior variables in relation to group variables. ½ or 1 unit. Prerequisite: Sociology 201 or Psychology 201; Psychology 235 or Sociology 385, or a comparable statistics course. MCGRATH, I. STEINER.

352. Attitude Theory and Measurement. Same as Psychology and Sociology 352. A comprehensive survey of psychological theories of attitude organization and change, and a theoretical and methodological analysis of the various techniques used to measure attitude. These theories and methods are evaluated with respect to empirical research in the area. ½ or 1 unit. Prerequisite: Sociology 201 or Psychology 201; a course in statistics. FISHBEIN.

360. Educational Uses of Television and Radio. Same as Educational Psychology and Radio-Television 360. A study of television and radio as educational instruments, and standards necessary for such use; production, utilization, planning, and evaluation; primary and secondary uses. Identification of the unique contributions and resources of the electronic media, as well as their limitations. Experimentation into new production and utilization techniques designed for educational uses. ½ unit. SKORNIA.

370. Language, Culture, and Society. Same as Anthropology and Linguistics 370. An examination of the social and cultural functions of language, with particular emphasis on the application of linguistic methods and findings to selected problems in the social sciences. ½ or 1 unit. BRUKMAN.

COMPARATIVE LITERATURE

The program leading to the degrees of Master of Arts and Doctor of Philosophy in Comparative Literature is designed to make possible a systematic study of subjects and problems common to several literatures. Its purpose is to enable students who have greater than average linguistic competence and preparation to explore (1) the interrelations of several literatures; (2) the main currents, periods, and movements in literary history; and (3) the theory of literature and criticism. The program is supervised by a committee made up of the heads and chairmen of the departments of modern languages and literatures and classics. The student's program of study is supervised by an adviser in the department of his major interest.

A student entering the program should have an undergraduate major in English, classics, or foreign languages with a grade-point average of at least 4.0 (on a 5.0 scale). Majors in history and philosophy may also be accepted with the special consent of the adviser.

Master of Arts. The candidate must demonstrate a competency in at least two foreign languages as well as in English. Some knowledge of Latin (or Greek) is highly recommended; Latin is necessary for students planning to specialize in the Middle Ages, the Renaissance, or Neo-Classicism. Competency in the languages offered is measured either by the successful completion of one advanced course in the literature of each of the languages chosen or by passing an examination administered by the Program in Comparative Literature with the assistance of an expert in the language concerned. This choice is intended to provide for exotic languages which may not be taught in regular departments.

The candidate must also acquire eight units of credit (general requirement of the Graduate College) including Comparative Literature 401 and one other seminar in Comparative Literature (451, 452, 461, 462). The other six units must be taken in two or three national literatures in a distribution approved by the adviser; at least five of the eight units must be taken in courses at the 400 level. The candidate must also pass a written examination (based on a reading list) which is designed to test his knowledge of literary history as well as his ability to interpret a literary or critical text. In addition he must write a thesis devoted to a problem embracing at least two national literatures.

Doctor of Philosophy. A candidate for the Doctor of Philosophy in Comparative Literature must fulfill the general requirements of the Graduate College including those specified above for the master's degree. He must demonstrate a competency in at least three foreign languages as well as in English. These three languages must coincide with those vital to the student's dissertation and his area of specialization. The candidate must choose at least four units of work from Comparative Literature seminars (451, 452, 461, 462). Four additional units work at the 400 level must be taken in courses regularly offered by the literature departments. The candidate is responsible for a knowledge of the history of the literature in one modern language. He must also select a period of major interest, and be responsible for a knowledge of two other literatures in this period, which are considered as minors. The periods may be (1) Medieval, (2) Renaissance, (3) Neo-Classical and Enlightenment, or (4) Modern (nineteenth and twentieth centuries). He must pass a preliminary examination (a three-part written examination based on his individual program, plus an oral examination), and present a dissertation embracing several national literatures.

GRADUATE FACULTY

Professors: F. Jost (Director of the Graduate Program in Comparative Literature), A. O. Aldridge, J. J. Bateman, J. J. Campbell, J. T. Flanagan, J. R. Frey, R. H. Green, H. R. Kahane, R. Montano.

Associate Professors: H. Knust, J. K. Simon.

COURSES FOR GRADUATES

401. Theory of Literature. The methods and objectives of the discipline of comparative literature. 1 unit. Prerequisite: Reading knowledge of two foreign languages; consent of instructor.

451. Seminar in Literary Movements. An investigation of the development and mutation of literary movements (classicism, romanticism, symbolism, etc.) through a study of critical texts and their reception in various countries. The

subject of the seminar varies each semester, and it may be taken more than once for a total of three units. 1 unit.

452. Seminar in Literary Relations. An investigation of the impact of one literature upon another, or of some specific works upon others (the role of English literature in Continental Europe; the influence of Russian novelists on French and German writers, etc.) . The subject of the seminar varies each semester, and it may be taken more than once for a total of three units. 1 unit.

461. Seminar in Literary Forms. A study of a form (the lyric, the novel, the drama, etc.) to discover its essential components in all the literatures studied and the significance of national variations. The subject of the seminar varies each semester, and it may be taken more than once for a total of three units. 1 unit.

462. Seminar in Literary Themes and Types. A study of a theme or type (the Faust myth, the romantic hero, etc.) to discover its essential components in all the literatures studied and the significance of national variations. The subject of the seminar varies each semester, and it may be taken more than once for a total of three units. 1 unit.

493. Special Studies. 1/4 to 1 unit.

499. Thesis Research. Intended for students engaged in writing a thesis as a partial requirement for the A.M. or Ph.D. degree in Comparative Literature. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

313. The Divine Comedy. Same as Italian 313. An interpretation of Dante's *Divine Comedy* with special attention to its position in the medieval world. A knowledge of Italian is not required. 1/2 unit.

359. The International Folk Tale. Same as English 359. A study of the origin, distribution, and nature of the folk tale with special reference to themes and variants. Representatives tales of various areas (Africa, Germany, Greece, India, Ireland, Japan, Norway) are analyzed, and North American Negro and Indian tales are discussed. 3/4 unit.

363. Introduction to Comparative Literature, I. Same as Humanities 363. A one-year course in two parts, offering a survey of methods and goals of comparative literature, illustrated by representative examples taken from several literatures and studies of modern criticism. 3/4 unit.

364. Introduction to Comparative Literature, II. Same as Humanities 364. Continuation of Comparative Literature and Humanities 363. 3/4 unit.

394. Introduction to Folklore: History, Theory, Methods. Same as English, German, Slavic 394, and Speech 346. An introduction to the study of folklore with emphasis on folk cultures in the Old and New World; an historical survey of the development of folklore study, an analysis of the methods and genres of folklore, and an introduction to field collecting and evaluation of archival materials. 3/4 unit. Prerequisite: A reading knowledge of one modern foreign language is recommended.

COMPUTER SCIENCE

The Department of Computer Science offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy in Computer Science. There is opportunity for specialization in circuit design, digital computer arithmetic switching and automata theory, computer organization, computer applications in

physical science, software systems and languages, numerical analysis, pattern recognition, and information retrieval.

The admission average is 4.0 for the last sixty semester hours of undergraduate work. Applicants with an average below 4.0 but above 3.75 are considered on an individual basis. Course prerequisites are twenty semester hours of electrical engineering, mathematics, or physics, including Computer Science 201 and 294, and one course in either Computer Science 301, 387, 391, or their equivalents. Since this is an interdisciplinary program, applicants whose programs are deficient in some of these areas are considered individually.

The requirements for the Master of Science degree in Computer Science include a thesis, in addition to the general requirements of the Graduate College.

The requirements for the Doctor of Philosophy degree in Computer Science include satisfactory achievement on a qualifying examination covering the areas of computer design, computer hardware, computer programming, and numerical analysis, in addition to the general requirements of the Graduate College.

Further details of this program are available from the Department of Computer Science.

The department provides service computing facilities for the educational and research programs of the University. At present, an IBM 360/50-75 system is operated.

GRADUATE FACULTY

Professors: J. R. Pasta (Head of Department), L. D. Fosdick, C. W. Gear, D. B. Gillies, B. H. McCormick, S. Muroga, T. A. Murrell, W. J. Poppelbaum, J. E. Robertson, D. L. Slotnick, J. N. Snyder (Associate Head of Department).

Associate Professors: K. W. Dickman, D. J. Kuck, J. Nievergelt, S. R. Ray.

Assistant Professors: M. Faiman, H. G. Friedman, R. S. Northcote, J. R. Phillips, P. E. Saylor.

COURSES FOR GRADUATES

400. Introduction to Automatic Digital Computing for Graduate Students. A beginning course covering the programming of digital computers using procedure oriented language. No graduate credit.

413. Computer Applications in Social Statistical Research. Same as Psychology and Sociology 413. Computer procedures for the analysis of sociological and psychological data, including probability matrices, dominance matrices, clique analysis, regression analysis, analysis of variance and covariance, canonical correlations, discriminant analysis, and factor analysis. 1 unit. Prerequisite: Sociology 387 or equivalent in statistics; may be taken concurrently with Sociology 387.

414. Engineering Applications of Linear Graphs. Same as Electrical Engineering 414. Elementary theory of linear graphs, Euler graphs; incidence, cut-set and circuit matrices and their properties; realizability of cut-set, circuit and tree matrices; applications to network analysis and synthesis; signal flow graphs; applications to switching circuits and automata; communication networks. 1 unit. Prerequisite: Electrical Engineering 416; Mathematics 315 or 318.

456. Coding Theory. Same as Electrical Engineering 456. General discussion on coding theory with emphasis on the algebraic theory of cyclic codes; error-control procedures and circuits; applications to computers and data transmission systems. 1 unit. Prerequisite: Mathematics 317 or equivalent, or consent of instructor.

457. Advanced Numerical Analysis. Same as Mathematics 457. Ordinary differential equations: existence theory of Picard, one-step and multi-step methods, discretization error, convergence, stability, boundary value problems; integral equations. 1 unit. Prerequisite: Computer Science or Mathematics 387, or consent of instructor.

458. Numerical Solution of Partial Differential Equations. Same as Mathematics 458. The numerical solution of initial and boundary value problems for partial differential equations; topics include the approximation of differential operators by difference operators, the solution of large systems of linear equations by interative methods, and discussion of convergence and numerical stability. 1 unit. Prerequisite: Computer Science or Mathematics 457, or consent of instructor.

463. Information Theory. Same as Electrical Engineering and Mathematics 463. Mathematical models for information channels and sources; existence theorems for and construction of error-correcting codes. 1 unit. Prerequisite: Mathematics 361 or equivalent.

465. Topics in Automata Theory. Same as Electrical Engineering and Mathematics 465. Topics selected from mathematical systems and automata theory, decision problems, formal languages, decomposition theory, etc. 1 unit. Prerequisite: Computer Science, Electrical Engineering, or Mathematics 392, or consent of instructor.

481. Threshold Logic. Same as Electrical Engineering 481. Mathematical model of computer elements which work under threshold or majority principle; mathematical theory of threshold functions; realizability using a linear programming approach; network syntheses of majority principle devices. 1 unit. Prerequisite: Consent of instructor.

482. Theory of Digital Computer Arithmetic. Same as Electrical Engineering 482. This course emphasizes the use of redundancy in the representation of digits in order to increase the efficiency of computer arithmetic. Topics include multiplier recoding, division with redundantly represented quotients, and structural redundancy as implied by carry-save and signed-digit techniques. 1 unit. Prerequisite: Computer Science or Electrical Engineering 394.

485. Advanced Theory of Magnetic and Optic Computer Memory Devices. Same as Electrical Engineering 485. Theory of ferromagnetism and superconductivity applied to memory devices; light propagation in anisotropic media; modulators and deflectors; principles of laser operation. 1 unit. Prerequisite: Computer Science or Electrical Engineering 385.

487. Theory of Approximation. Same as Mathematics 487. General approximation theory in normed linear spaces with primary emphasis on functions defined on an interval, and periodic functions; existence and uniqueness theorems; characterization of Chebyshev approximants; degree of approximation; interpolation with emphasis on the quality of interpolants as approximants; use of approximations in computing. 1 unit. Prerequisite: Mathematics 318, 348, or consent of instructor.

490. Individual Study. Individual study or reading in a subject not covered in normal course offerings. ½ to 2 units. Prerequisite: Consent of instructor.

491. Seminar in Computer Science. Seminar on topics of current interest. Subjects will be announced in the Time Table. ½ to 1 unit. Prerequisite: Consent of instructor.

497. Special Topics in Computer Science. Lecture course in topics of current interest. Subjects will be announced in the Time Table. ½ to 1 unit. Prerequisite: Consent of instructor.

499. Thesis Research. Section A, for master's degree candidates; Section B, for doctoral degree candidates. 0 to 4 units. Prerequisite: Consent of instructor.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Programming, Languages, and Computation. An introduction to mathematical models of programming languages and computation on a digital computer; phrase structure languages, particularly context free languages, and their syntactic analysis with application to translation; abstract models of digital computers and the computations which they can perform subject to various restrictions on control, memory, and time; unsolvability results for computations and languages. 1 unit. Prerequisite: Computer Science 201 or consent of instructor.

306. Machine Language and System Programming, II. Principles of programming; procedure and problem oriented languages—use and implementation; problems in system programming for input/output channels and time sharing. 1 unit. Prerequisite: Computer Science 201 or consent of instructor.

311. Mathematical Theory of Data Processing. Mathematical structure and automatic processing of extensive files of data are developed employing methods from statistics, graph theory, and information theory. Topics discussed include: the selective screening and classification of data (pattern recognition, machine abstracting, optimum encoding, least square adjustment of data); and file organization and maintenance (information retrieval, indexing, and scheduling). 1 unit. Prerequisite: Computer Science 101, 121, or consent of instructor.

365. Digital Computer Methods for Statistical Data Processing. Same as Agronomy 365. A study of computing methods for efficient utilization of high-speed equipment in the processing of statistical data. Emphasis is on principles of application of computing equipment to the solution of statistical problems. Numerous examples are given and actual problem solution by the student is accomplished. 1 unit. Prerequisite: Computer Science 101, 103, 107, or 121, and a course in statistics or statistical methods or equivalent, or consent of instructor.

385. Theory of Semiconductor Computer Devices. Same as Electrical Engineering 385. Crystal conduction; large signal d-c and transient behavior of semiconductor devices; charge storage theory, phase plane diagrams, tolerance optimization and noise theory; integrated circuits technology: masking, oxidizing, and etching; emphasis on development of device-theoretical background for computer logic design. ¾ or 1 unit. Prerequisite: Computer Science or Electrical Engineering 294, or consent of instructor.

387. Numerical Analysis. Same as Mathematics 387. The main topics discussed in this course are error analysis and algorithms for: the solution of equations; the computation of eigenvalues and eigenvectors; numerical quadrature; numerical approximation of functions. 1 unit. Prerequisite: Computer Science 287; a knowledge of elementary matrix algebra or consent of instructor.

391. Boolean Algebra and Switching Theory. Same as Mathematics and Electrical Engineering 391. Boolean algebra with applications to sets, logic, electronic and relay combinational circuits; Karnaugh and Quine-McCluskey minimization procedures with applications; introduction to sequential circuits. 1 unit. Prerequisite: Consent of instructor.

392. Introduction to Automata Theory. Same as Mathematics and Electrical Engineering 392. Semigroups, partially ordered sets, and other algebraic systems; asynchronous machines; abstract synchronous machines and their properties; regular sets; decomposition theory. ½ or 1 unit. Prerequisite: Electrical Engineering, Computer Science, or Mathematics 391, or consent of instructor.

393. Digital Computer Circuit Design. Same as Electrical Engineering 393. Design of switching circuits and systems taking into account properties of currently available diodes, transistors, and related circuit elements; applications to slow-speed as well as high-speed computer circuits and data handling links; component tolerance, circuit reliability, and cost factors are considered. 1 unit. Prerequisite: Electrical Engineering 342; Computer Science or Electrical Engineering 294 or 391; or consent of instructor.

394. Logical Design of Automatic Digital Computer Circuits. Same as Electrical Engineering 394. A course in the design of automatic digital computers. Major emphasis is on logical structure of components and the interrelations necessary for automatic operation. 1 unit. Prerequisite: Electrical Engineering 294; consent of instructor.

397. Special Topics in Computer Science. Lecture courses in topics of current interest. Subjects will be announced in the Time Table. ½ to 1 unit. Prerequisite: Consent of instructor.

DAIRY SCIENCE

The Department of Dairy Science offers graduate work leading to the Master of Science and Doctor of Philosophy. This work is given in five chief fields of specialization: dairy bacteriology and microbiology, dairy biochemistry, dairy cattle feeding and nutrition, dairy cattle breeding and genetics, and physiology of lactation and reproduction.

For admission to full standing, an applicant's undergraduate grade-point average must be at least 3.75.

For a major in dairy science for either advanced degree, students must select, with the advice of the head of the department, a faculty adviser in the separate area of study desired. Candidates for the Master of Science must complete one-half unit of seminar and two units of thesis research. For the Doctor of Philosophy, one and eight units, respectively, of these courses are required. Other course requirements depend upon the area of study in which the student specializes and upon his background training. Information concerning such requirements may be obtained from the departmental office.

Candidates for the Master of Science are expected to complete an acceptable thesis unless the Dean of the Graduate College waives this requirement. All students expecting to continue graduate studies should fulfill the thesis requirements for the master's degree. A comprehensive examination concerning the thesis and the general field of dairy science also is required.

For a minor in dairy science, students should select an adviser in this area of study to determine the specific courses required. For the Master of Science, the minimum requirements for a first minor are two units in dairy science, and for a second minor, one unit in dairy science.

For the Doctor of Philosophy, the minimum requirements for a sole minor are four units of dairy science, of which two units must be in 400-level courses; for a first minor, three units in dairy science; and for a second minor, two units in dairy science.

GRADUATE FACULTY

Professors: G. W. Salisbury (Head of Department), H. P. Broquist, R. E. Brown, M. P. Bryant, K. E. Harshbarger, R. L. Hays, K. A. Kendall, B. L. Larson, R. W. Touchberry, M. J. Wolin.

Associate Professors: J. H. Byers, C. L. Davis, C. N. Graves, J. R. Lodge.

COURSES FOR GRADUATES

402. **The Microbiology and Physiology of Ruminant Nutrition.** The physiological and microbiological aspects of ruminant digestion and their influence on the metabolism of the extraruminal tissues; interpretation of nutritive requirements in terms of rumen microbial activities and evaluation of research techniques. ¾ unit. Prerequisite: Chemistry 350, 355, or equivalent. BROWN, BRYANT.

408. **Physiology of Lactation.** The anatomy and endocrinology of mammary development; the environmental, endocrinological, and biochemical factors which affect the yield and composition of milk. ½ to 2 units. HAYS.

411. **Population Genetics and Animal Breeding.** Same as Animal Science 411. The mathematical theory of population genetics and its application to the improvement of farm animals; results of different systems of mating and the expected gains from different methods of selection. 1 unit. Prerequisite: Dairy Science 110 or equivalent. A knowledge of elementary algebra is essential. TOUCHBERRY.

412. **Advanced Endocrinology.** Same as Animal Science, Physiology, and Zoology 412. Seminar, lectures, student reports, and discussions of recent advances in endocrinology. This course may be repeated for credit not to exceed a total of two units. ½ unit. Prerequisite: Consent of instructor. GORSKI, NALBANDOV.

430. **Physiology of Mammalian Germ Cells.** A literature and laboratory course covering the recent theories and developments on the formation, transportation, and livability of spermatozoa and ova within the body, and their metabolism and preservation *in vitro*. 1 unit. Prerequisite: Dairy Science 330, Animal Science 406, and Chemistry 350, or consent of instructor. LODGE, SALISBURY.

440. **Design and Analysis of Biological Experiments.** Same as Agricultural Engineering, Agronomy, Animal Science, Food Science, Forestry, Horticulture, and Veterinary Medical Science 440. Statistical methods as tools for research. Principles of designing experiments and methods of analysis for various kinds of designs, including factorial experiments, are considered from the viewpoint of when and how to use them. ¾ unit. Prerequisite: Dairy Science 340 or equivalent. SEIF.

450. **Dairy Bacteriology.** Assigned laboratory problems in dairy bacteriology. ½ to 2 units. Prerequisite: Ten hours of advanced microbiology and/or chemistry; consent of instructor. BRYANT, WOLIN.

481. **Animal Biochemical Laboratory Techniques.** Same as Animal Science 481. Theory and application of biochemical laboratory techniques to research in the animal-oriented biological sciences. Isolation, characterization, and analysis of biological compounds including enzymes, metabolic intermediates, and cellular components; determination of metabolic pathways and processes. 1 unit. Prerequisite: Chemistry 350 and 355; consent of instructor. LARSON.

490. **Dairy Science Seminar.** Current literature relating to various phases of dairy science. ½ unit. Prerequisite: Graduate major or minor in dairy science. SALISBURY.

493. **Special Problems.** Individual investigations in any phase of dairy science. ½ to 2 units. BROQUIST, BROWN, BRYANT, BYERS, DAVIS, GRAVES, HARSHBARGER, HAYS, KENDALL, LARSON, LODGE, SALISBURY, TOUCHBERRY, WOLIN.

499. **Thesis Research.** 0 to 4 units. BROQUIST, BROWN, BRYANT, BYERS, DAVIS, GRAVES, HARSHBARGER, HAYS, KENDALL, LARSON, LODGE, SALISBURY, TOUCHBERRY, WOLIN.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Special Problems. Supervised research on any phase of dairy science, including bacteriology and microbiology, biochemistry, feeding and nutrition, genetics, and physiology. ½ or 1 unit. Prerequisite: Approval of head of department. BROQUIST, BROWN, BRYANT, BYERS, DAVIS, GRAVES. HARSHBARGER, HAYS, KENDALL, LARSON, LODGE, SALISBURY, TOUCHBERRY, WOLIN.

305. Genetics and Animal Improvement. Same as Animal Science 305. The principles of heredity and their application to the problem of animal improvement. ¾ unit; S, ½ unit. Prerequisite: Dairy Science 110 or equivalent. RASMUSEN, TOUCHBERRY.

320. Nutrition and Digestive Physiology of Ruminants. Same as Animal Science 320. The physiology and microbiology of digestion in the ruminant and bio-chemical pathways of utilization of the absorbed nutrients for productive purposes. ¾ unit. Prerequisite: Dairy Science or Animal Science 221. DAVIS, HINDS.

330. Reproduction and Artificial Insemination of Farm Animals. Same as Animal Science 330. The anatomy and physiology of reproduction in farm animals, the principles of artificial insemination, and the factors affecting conception in natural and artificial breeding. ¾ unit; S, ½ unit. Prerequisite: Zoology 104; Dairy Science 100 or Animal Science 100. GRAVES, LODGE.

334. Marketing Dairy Products. Same as Agricultural Economics 334. Economic interrelationships of various dairy products; collective bargaining; federal milk orders, mark-up laws, marketing quotas, and other governmental regulations; lowering distribution costs; factors affecting demand and consumption; expanding markets for dairy products. Inspection trip; estimated expense, $5.00. ¾ or 1 unit. Prerequisite: Agricultural Economics 230, an elementary marketing course, or twelve hours of dairy science or dairy technology. GRUEBELE.

340. Introduction to Applied Statistics. Same as Agricultural Engineering, Agronomy, Animal Science, Food Science, Forestry, Horticulture, and Veterinary Medical Science 340. Statistical methods involving relationships between populations and samples; collection, organization, and analysis of data; techniques in testing hypotheses with an introduction to regression, correlation, and analyses of variance limited to the completely randomized design and the randomized complete-block design. ¾ unit. Prerequisite: Mathematics 111 or 112 or 104, or equivalent. SEIF.

350. World Animal Agriculture. Same as Animal Science 350. Survey and interpretations of the role of animal agriculture in various cultures of the world with particular references to underdeveloped countries of the world. The importance of improved animal agriculture for land resource utilization and for meeting food and animal power needs of people are discussed. ¾ unit. Prerequisite: Consent of instructor.

DANCE

The Department of Dance offers a program of graduate study leading to the Master of Arts in Dance. This program offers advanced work in choreography, dance production, and pedagogy, with emphasis on the related fields of art, music, and theatre.

Admission requirements for a major in this field are: (1) a minimum grade-point average of 3.5; (2) twenty-four semester hours of approved undergraduate credit in dance (at least eight hours), art, music, theatre, and physical education; (3) thirty-six semester hours in humanities (literature, language, and philosophy),

natural sciences (biological and physical sciences), and social sciences (history, political science, psychology, anthropology, sociology, education). Applicants lacking a portion of the prerequisites under item (2) may substitute certified experience in dance not to exceed eight semester hours.

Satisfaction of the general requirements for admission to the Graduate College and to this program does not in itself necessarily qualify the student as a degree candidate. The Department of Dance also reserves the right to accept for advanced study only those students whose preparation in dance has been obtained in certain approved institutions.

Of the eight units required for the Master of Arts, a minimum of four must be in dance, or (subject to the approval of the supervisor) in dance and related areas such as art, music, theatre, and speech; two units must be in one or more of the following fields: English, history, philosophy, anthropology, psychology, sociology, radio-television. The remaining two units are for the presentation of an acceptable thesis (Dance 499) and the accompanying noncredit course, Dance 490, Seminar. The thesis may be waived, with the approval of the adviser, but in lieu thereof the candidate must submit two units of course work (total of eight units), plus a recital of solo and group dances which he has choreographed and staged.

Not later than midpoint in the student's program, his work is reviewed in order to determine his status in terms of progress, ultimate completion, and awarding of the degree. The Department of Dance may extend the residence requirement (or increase the total requirements) at this time or any other time, if this seems warranted.

GRADUATE FACULTY

Professor: Margaret Erlanger.

Associate Professor: Janis Stockman (Acting Head of Department).

Assistant Professor: W. W. Ward, Jr.

COURSES FOR GRADUATES

400. Problems in Dance Education. Basic historical, philosophical, and scientific foundations and developments in dance education; teaching methods; development of compositional problems; creative methods of instruction; organizational problems of dance groups and public dance performance. 1 unit. Prerequisite: Dance 243 or 244, or equivalent. Staff.

401. Choreography. Experience in choreographing a minimum of one solo and one group composition to be presented at the end of the semester. ½ to 2 units. Prerequisite: Dance 345 or equivalent. Students may re-register for a maximum of two units with the permission of the head of the department. Staff.

490. Dance Seminar. Student presentation of thesis reports in dance; informal discussions, demonstrations, lectures, and critical analysis of current problems in dance by professional guests. No credit. Staff.

499. Thesis Research. Preparation of theses in dance. ½ to 2 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

340. History of Dance. A survey course tracing dance from its beginnings in primitive societies to its present art form. ½ unit. Prerequisite: Consent of instructor. Staff.

345. Dance Production Workshop. Experience in choreography and production of group compositions with special emphasis on staging, lighting, and costuming. ½ unit. Prerequisite: Dance 164 or equivalent; consent of instructor. Staff.

346. Theory and Philosophy of Dance. A study of the relationship of aesthetic principles and dance theory to a philosophy of dance in education and of dance as a performing art. ½ unit. Prerequisite: Consent of instructor. STAFF.

ECONOMICS

The Department of Economics offers graduate work leading to the Master of Arts, Master of Science, and Doctor of Philosophy.

A student who applies for admission to graduate study in economics must have a grade-point average of 4.0 or higher. Students with averages between 3.75 and 4.0 are considered on an individual basis. Applicants must have completed fifteen hours of undergraduate work in economics or have approval of the Director of Graduate Studies. The department recommends that the results of the Graduate Record Examination Aptitude Test accompany application for admission to the Graduate College. Information concerning the dates and places for taking this examination may be secured by writing to the Educational Testing Service, Box 955, Nassau Street, Princeton, New Jersey 08540.

The candidate for an advanced degree in economics may specialize in the following fields of economics: economic theory, history of economic thought, monetary theory and policy, public finance and taxation, growth and development, international economics, labor economics, economic history, comparative economic systems, transportation, econometrics, urban and regional economics, industrial organization, and mathematical economics.

Master of Arts or Master of Science. The following requirements must be met:

(1) Economic Theory. Two units of course work, consisting of 400-401, or 402-403; if the student has had 300-301 or their equivalent, he must take 402-403.

(2) Statistics. Proficiency in statistical analysis. This requirement may be met by taking Economics 470 or by passing a proficiency examination.

(3) History of Economic Thought or Economic History. One unit in either field at the 400 level.

(4) Course work beyond that required to bring the total to eight units, two of which may be master's thesis work, or successful completion of the written qualifying examination for the doctorate.

Doctor of Philosophy. The following requirements must be met:

(1) Economic Theory. Economics 402-403, plus one additional 400-level course in advanced economic theory.

(2) Statistics. The same demonstration of proficiency as for the master's degree.

(3) History of Economic Thought and Economic History. Passing a written preliminary examination in these subjects with one unit of 400-level course work in each.

(4) Specialized Fields. The student must select three additional fields, two of which must be in economics, and the third outside the department. At least two units of graduate work in courses in each field selected are required.

(5) Additional units to bring the total to twenty-four, of which eight must be doctoral dissertation units.

The candidate is required to pass an oral and written preliminary examination prior to beginning dissertation research, and an oral final examination covering his research. There is no general foreign language requirement; however, individual students may be required to demonstrate foreign language competence, if such competence is needed for their dissertation research.

GRADUATE FACULTY

Professors: M. FRANKEL (Chairman of Department), V L. BASSIE, R. BRANDIS, H. J. BREMS, J. F. DUE, R. FERBER, D. P. FLANDERS, H. W. GUTHRIE,

R. W. Harbeson, D. R. Hodgman, G. G. Judge, D. L. Kemmerer, W. H. McPherson, H. O. Nourse, D. W. Paden, J. B. Parrish, J. D. Phillips, T. Takayama, P. J. Wells.

Associate Professors: Grace Beckett, H. W. Folk, R. W. Gillespie, F. M. Gottheil, P. T. Hartman, A. J. Heins, W. W. McMahon, R. W. Resek, P. Schran, F. R. Shupp, J. L. Simon, C. M. Sprenkle, S. W. Steinkamp, Janet L. Weston, T. A. Yancey.

Assistant Professors: R. W. Cummings, J. Leuthold, J. R. Millar, M. E. Moyer, L. E. Weiser, P. Yeung.

COURSES FOR GRADUATES

400. General Economic Theory. Emphasis in this course is placed on micro-economic theory. The principal topics include: a review of value and distribution theory, the theory of choice by household and firms, general micro-economic theory; and theoretical developments of current interest. Attention is given to empirical studies intended to affirm or disaffirm economic principles. Intended for minors in economics and others who have a minimum preparation for graduate study in economics. 1 unit. Prerequisite: Economics 102, 103, or 108. Flanders.

401. General Economic Theory. Emphasis in this course is placed on macro-economic theory and the relationship of economics to the other social sciences. The principle topics include: a review of Keynesian macro-economic theory, formal growth theory, selected business cycle theory, the theory of socio-economic change, and an outline of the differentiation and integration of economics and other social sciences. Intended for minors in economics and others who have a minimum preparation for graduate study in economics. 1 unit. Prerequisite: Economics 102, 103, or 108. Flanders, Staff.

402. Economic Theory. This course develops modern micro-economic theory: utility functions and demand; production functions and cost; linear programming; price and nonprice policy by the firm; market equilibria; income distribution; general equilibrium including input-output analysis. The course is given in two sections, one offering a primarily mathematical presentation, the other, a primarily literary presentation. 1 unit. Prerequisite: Economics 300, 301, or equivalent; for the mathematical section, a knowledge of algebra and calculus. Staff.

403. Economic Theory. This course develops modern macro-economic theory; the Keynesian model of employment, interest, and money; its extension to international trade; fiscal policy and macro-economic theory of distribution; the consumption function; the theory of growth and cycles in terms of difference and differential equations. This course is given in two sections, one offering a primarily mathematical presentation, the other, a primarily literary presentation. 1 unit. Prerequisite: Economics 300, 301, or equivalent; for the mathematical section, a knowledge of algebra and calculus. Staff.

406. History of Economic Thought. An analysis of economic thought from the Physiocrats to the present; the materials selected are evaluated both as reflections of their times and as contributions to contemporary economic thought. 1 unit. Prerequisite: Economics 300 and 301, or equivalent. Brandis, Gottheil.

408. Philosophical Problems in Economics. The study of philosophical problems in economics, with some emphasis on the methodology and epistemology of economic theory. The views of leading economists are used to show the development of broad philosophical problems of economic theory, the relation of theory and certain of its applied areas, and the relation of economics to

other selected disciplines. These problems are treated in the light of modern scientific philosophy. 1 unit. Prerequisite: One unit either in economic theory or in the history of economic thought.

410. **Price and Distribution Theory.** A research-oriented seminar in micro-economic theory. Major topics treated include: comparative static analysis of demand, production, and the theory of markets; dynamic equilibrium; market dynamics. Sub-topics include axiomatics of preferences; ordinal and Bernoullian utility, revealed preference, and the interdependence of preferences; multiperiod production, utility, and consumption; the aggregation of micro-economic relationships; expectations and response lags; analysis of changing market structures; game theory. Offered in 1970-1971 and in alternate years. 1 unit. Prerequisite: Economics 402 and 470, or equivalent.

411. **Capital and Interest Theory.** A comprehensive and critical examination of the theory of capital and interest as the subject has been developed by the leading English and continental writers. Special attention is given to the optimal investment decision of the firm, capital accumulation and the efficient utilization of society's resources, and to the relation between capital and interest. Offered in 1969-1970 and in alternate years. 1 unit. Prerequisite: Economics 403 or consent of instructor. BREMS, SPRENKLE, WELLS.

412. **Advanced Aggregate Income Theory.** An analysis of the theory of income and employment with emphasis upon the measurement of income and product, money flows, and the relationship between input and output in the economy. Offered in 1969-1970 and in alternate years. 1 unit. Prerequisite: Economics 403 or consent of instructor. BREMS, PADEN, WELLS.

413. **Consumption Theory.** The theory of consumer behavior in modern economic analysis. Utility analysis at the micro level, consumer interdependence and problems of aggregation, econometric tests, aggregate consumption analysis in static and dynamic contexts, and the implications of the theory of consumer behavior for cyclical movements and economic growth. Offered in 1970-1971 and in alternate years. 1 unit. Prerequisite: Economics 400 or 402, or consent of instructor. FERBER, MCMAHON.

414. **Public Finance.** Analysis of government expenditures and decision making; the budgetary process; fiscal policy; government borrowing and debt management; intergovernmental fiscal relations; pricing of government services; public finance in developing economies. 1 unit. Prerequisite: Six hours of economics. DUE, HEINS.

415. **Economics of Taxation.** Principles of taxation; incidence and distribution of tax burden; economic analysis of the major taxes: the personal and corporate income taxes, sales and excise taxes, property tax, and others; taxation and economic development. 1 unit. Prerequisite: Six hours of economics. DUE, HEINS.

420. **Monetary Theory.** A critical examination of monetary theories and their neoclassical antecedents. Among the topics considered are the quantity theory, liquidity preference, the demand for money, velocity, theories of the level and term structure of interest rates, asset theory, and money in static and dynamic macro-general equilibrium models. 1 unit. Prerequisite: A course in income and employment theory or consent of instructor. HODGMAN, SPRENKLE.

421. **The Theory of Monetary Policy.** Theories of central banking, debt management, financial intermediaries, and the monetary behavior of firms and households are used to explore current issues in the theory of monetary policy. Current empirical research is reviewed with particular emphasis on econometric studies of monetary behavior. 1 unit. Prerequisite: A course in money and

banking, in macro-economic theory, calculus, and statistics, or consent of instructor. HODGMAN, SPRENKLE.

425. **Macro-Accounting.** Same as Accountancy 455. An examination of the fundamental concepts underlying the attempt to measure the economic activities of macro-units; similarities and contrasts of accounting problems, theoretical and practical, of the business enterprise and of national or regional units in relationship to existing systems of accounting measurement; macro-accounting statements and analyses; usefulness of macro-accounting techniques and data in evaluating national and regional goals, 1 unit. Prerequisite: Intermediate macro-accounting theory or consent of instructor.

428. **International Trade Theory.** The neoclassical theory of international trade is developed and then used for the analysis of tariffs, customs, unions, and the effects of trade on the distribution of income and welfare. The relations between the balance of payments and national income are analyzed and used to study the role of income changes combined with price changes in the balance of payments adjustment process. 1 unit. Prerequisite: Economics 300 and 301, or equivalent. GILLESPIE, WEISER.

429. **International Trade Policy.** Concepts of balance of payments equilibrium, the foreign exchange market and the theory of capital movements; current problems and policies related to balance of payments desequilibrium, trade policy, and the functioning of the international monetary system. 1 unit. Prerequisite: Economics 300 and 301, or equivalent. CUMMINGS, GILLESPIE.

436. **American Economic History.** Colonization, westward movement, agriculture, transportation, industrial revolution, trust movement, slavery, labor conditions and organizations, capital growth, money and banking, foreign and domestic commerce, and social progress. Material chiefly since 1790. Not open to students who have had Economics 236. 1 unit. KEMMERER.

438. **Economic History of Europe.** The major lines of development since 1450; comparative study of forces and institutions inimical or favorable to growth; selected readings on organization of economic activity, role of governments and the entrepreneur, commercial policy, monetary systems, land tenure, process of capital formation, industrialization, etc. 1 unit. Prerequisite: Consent of instructor.

440. **Labor Economics.** Same as Labor and Industrial Relations 440. A survey of recent trends in the labor force, of real and money earnings, and of the distribution of national income. This review of recent trends in these areas is used as the basis for a critical economic analysis of contemporary English and American wage theory. 1 unit. Prerequisite: A minimum of six hours of economics.

441. **Labor Economics.** Same as Labor and Industrial Relations 441. The economic issues and implications involved in hours of work, employment and unemployment, and trade union institutionalism (the impact of the trade union upon the basic institution of a free enterprise economy). Emphasis in all cases is upon the development of appropriate public policy. 1 unit. Prerequisite: A minimum of six hours of economics.

442. **Collective Bargaining.** Same as Labor and Industrial Relations 442. The development of a theory of the continuing interactions between unions and management which define and modify the role of each and the terms of employment. Appropriate social science concepts are used. Emphasis is on the negotiating process, the structure of bargaining, and such issues as wages, worker security, and management authority as well as on the interactions

between the parties and governmental process. 1 unit. Prerequisite: Consent of instructor.

443. Problems and Practices of Labor Dispute Settlement. Same as Labor and Industrial Relations 443. Seminar in the policies and practices of labor contract administration; comparative study of the fundamentals of grievance handling, analysis of mediation and fact-finding techniques; and special emphasis on the use of arbitration as a means of reducing industrial conflict. 1 unit. Prerequisite: Consent of instructor. McPHERSON.

444. Economics of Manpower Resources. Same as Labor and Industrial Relations 444. Emergence of the manpower resource issue; population as a resource base; the labor force; measurement and characteristics, behavior under changing income, employment, technology; women as the dynamic factor in labor force growth; problems of utilization of labor force components; intellectual resources, older workers, manual, white collar, Negro, marginal forces; issues of national manpower policy. 1 unit. Prerequisite: Consent of instructor. PARRISH.

447. Labor Union Organization and Administration. Same as Labor and Industrial Relations 447. Analysis of the structure, functions, and government of the modern American trade union movement. Provides a survey of the environmental factors, objectives, and action programs with considerable emphasis on economic as well as internal institutional factors, including the roles of leaders, policy determination and execution, jurisdictional disputes, and governmental regulations. 1 unit. Prerequisite: Major in social science or consent of instructor. GARMAN.

450. The Economics of Development and Growth. Review and analysis of the theories and patterns of growth in developed and underdeveloped economies. The problems and methods of measuring growth are considered, the variables thought to be strategic in the growth process are critically examined, and the policy implications of different theories are explored. 1 unit. Prerequisite: Economics 300 and 301, or equivalent. FRANKEL.

451. The Developing Economies. An analysis of the newly-developing economies, with emphasis on institutional factors affecting development, and economic policy relating to development. 1 unit. Prerequisite: Economics 450. STAFF.

455. Comparative Economic Systems. A comparative analysis of the structures and policies of market-directed and planned economies. 1 unit. Prerequisite: Economics 103 or 108 or equivalent. GOTTHEIL.

457. Economic Planning in the Soviet Union and Eastern Europe. An intensive examination of the structure and performance of the Soviet and the East European economies, emphasizing analysis of the main theoretic and operational dimensions of economic planning; choice, design, and efficacy of central planning instruments are evaluated from both theoretical and historical perspectives. 1 unit. Prerequisite: Economics 357, 450, or 455, or a reading knowledge of Russian. MILLAR.

460. Location Theory. The theory of location of economic activity in modern economic analysis; production and location theories are synthesized and applied to regional structure and interregional and international trade and development. A student can not receive graduate credit for both Economics 360 and 460 or 461. 1 unit. Prerequisite: Economics 300 and 301, or equivalent. NOURSE

461. Urban and Regional Economic Development. Measurement and analysis of interregional differences in economic growth. A student can not receive graduate credit for both Economics 360 and 460 or 461. 1 unit. Prerequisite: Economics 300 and 301. NOURSE.

467. Mathematical Economics, I: Statics. A study of quantitative techniques useful in economic analysis and decision making. Mathematical programming, input-output analysis, point-set theory and game theory, existence, optimality and stability conditions for static general equilibrium, activity analysis, including welfare economics. 1 unit. Prerequisite: Mathematics 315; Economics 402, 403; or equivalent.

468. Mathematical Economics, II: Dynamics. A study of quantitative techniques useful in economic analysis and decision making. Single and systems of difference and differential equations, dynamic programming, Pontryagin maximum principle, interaction of multiplier and accelerator, von Neumann model, Turnpike Theorem, growth models, control systems. 1 unit. Prerequisite: Mathematics 315; Economics 402, 403; or equivalent.

470. Economic Statistics. Classical statistics and regression analysis; descriptive statistics, probability, point and interval estimation, decision theory, variance analysis, linear regression, and least squares estimates. 1 unit. Prerequisite: Consent of instructor.

471. Economic Statistics. Part 1: the construction of econometric models; characteristics of models and choice of estimating methods; estimates of parameters by various methods. Part 2: Bayesian statistics and decision theory. 1 unit. Prerequisite: Economics 470 or equivalent. YANCEY.

473. Economic Forecasting. Forecasting techniques; analysis of important forecasting situations in terms of strategic forces and relationships; the place of judgment in evaluating current information, selecting critical factors, and appraising the validity of analytical techniques. Offered in 1970-1971 and in alternate years. 1 unit. Prerequisite: Economics 171 and 312 or 373 or equivalent. BASSIE.

476. Econometrics, I. Estimation of parameters for single equation models; tests of hypotheses and confidence regions for regression models; large sample theory in single equation models; Bayesian statistics in regression models. 1 unit. Prerequisite: Mathematics 315 and 363. JUDGE, RESEK, YANCEY.

477. Econometrics, II. Specification of models with systems of simultaneous equations; identification problem, distributed lag models, K-class estimators, maximum likelihood estimators, three stage least squares, and effects of specification errors are considered. 1 unit. Prerequisite: Economics 476. JUDGE, RESEK, YANCEY.

479. Research Seminar in Quantitative Economics. Significant work in the area of quantitative economics is reported and explored by members of the instructional staff, by guest speakers from academic, governmental, and industrial centers, and by graduate students in the second year of their work who are assigned projects. Offered in 1970-1971 and in alternate years. 1 unit. Prerequisite: The equivalent of one year of graduate statistics (theoretical or applied), calculus, and the equivalent of one year of mathematical economics. FERBER.

480. Industrial Organization. Theory of the organization of markets and firms, behavior of firms, functioning of competitive systems, performance of markets. 1 unit.

481. Industrial Organization and Public Policy. The economic aspects of public policy relating to the maintenance of competition, public utility regulation, and natural resource regulation. A survey of other forms of regulation and market organization in other countries. 1 unit. Prerequisite: Economics 480.

484. Economics of Transportation. A study of the principal economic problems arising in connection with the development and regulation of railroads and other modes of transport. 1 unit. HARBESON.

485. Economics of Transportation. A study of the principal economic problems arising in connection with the development and regulation of railroads and other modes of transport. 1 unit. HARBESON.

490. Individual Study and Research. Directed reading and research. ½ to 1 unit. STAFF.

499. Thesis Research. Preparation of thesis required of all students writing master's or doctor's theses in economics. 0 to 4 units; S, 0 to 2 units. Master's theses, FLANDERS; doctor's theses, FRANKEL.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Intermediate Micro-Economic Theory. Micro-economic analysis including value and distribution theory. Topics include the analysis of demand, the theory of the firm and the industry, and the analysis of the pricing of the factors of production. Each topic is integrated in a micro-general equilibrium context which builds toward explaining the resource allocation process. ½ unit. Prerequisite: Economics 103 or 108. Students may not receive credit for both Economics 200 and 300. STAFF.

301. Intermediate Macro-Economic Theory. The modern theory of the determination of the level and rate of growth of income, employment, output, and the price level. Alternate fiscal and monetary policies to facilitate full employment and economic growth are discussed. Prerequisite: Economics 103 or 108. ½ unit. STAFF.

302. Economic Analysis. An introduction to the theory of income and employment, price and allocation, and instability and growth. S; ½ or 1 unit. Prerequisite: Economics 103 or 108, enrollment in National Science Foundation Summer Institute in Economics, or consent of instructor. PADEN.

306. History of Economic Thought. A study of the development of economics. Contributions of schools of thought and individual writers are examined in their settings and as they influenced economic thought and national policy. ½ unit. Prerequisite: Economics 103 or 108.

312. Economic Dynamics and Growth. An analysis of the causes of economic instability; the requirements for economic growth in the national economy, and a consideration of public policy relating to instability and growth. ½ or 1 unit. Prerequisite: Economics 108 or 103 and 301.

313. Economics of Consumption. Same as Home Economics 313. An analysis of the macro and micro aspects of consumption. ½ or 1 unit. Prerequisite: Economics 102 or 108; a course in applied statistics. DUNSING.

328. International Economics. An introduction to the theory of international trade and finance with selected application to current problems of commercial policy, balance of payments adjustment, and the international monetary system. ½ or 1 unit. Prerequisite: Economics 102 and 103, or Economics 108.

329. Contemporary Issues in the International Economy. Analysis in depth of selected current issues and policy problems of the international economy. The topics may include but not be restricted to the following: new approaches to the theory of international trade, reform of the international monetary system, role of the General Agreement on Trade and Tariffs and United Nations Commission on Trade and Development in expanding trade between developed and undeveloped economies, problems of stabilizing international commodity markets, balance of payments problems of the United States and other selected countries. ½ or 1 unit. Prerequisite: Economics 328 or equivalent.

335. American Financial History. American monetary history and the development of the present monetary system, the rise of commercial, investment, and central banking and of other financial institutions, and the financing of government, especially of major wars. ½ or 1 unit. Prerequisite: Finance 250. KEMMERER.

337. Economic History of American Agriculture. Same as Agricultural Economics and History 337. The development of American agriculture from early colonial times to the present. Emphasis on regional development, evolution of methods and equipment, trends in marketing and credit, and the making of federal farm policy. ½ or 1 unit. Prerequisite: A college-level course in basic economics or American history.

342. Economics of Social Security. Same as Labor and Industrial Relations 342. A critical analysis of the economic issues and problems involved in our legislative efforts to reduce the economic risks of unemployment, old age dependency, and industrial injuries. ½ or 1 unit. Prerequisite: Economics 103 or 108.

343. Economics of Trade Unionism and Collective Bargaining. Theory of the labor movement, union growth and the maturity doctrine, union wage determination and implications for income distribution and national wage-price policy, adjustment to changing technology, strategies in collective bargaining, problems and policies of government intervention. ½ or 1 unit. Prerequisite: Economics 103 or 108 and 240.

344. The Law and Labor. Same as Labor and Industrial Relations 344. An economic analysis of the problems and issues arising out of the legislative and judicial efforts to define the rights, duties, and responsibilities of labor organizations and management in the field of industrial relations. ½ or 1 unit. Prerequisite: Economics 103 or 108; Economics 240.

345. Economics of Manpower. Manpower training in economic growth, labor force characteristics, occupational structure and future manpower requirements, job information networks, economics of discrimination and underutilization, national manpower policies and programs, private industry and union manpower planning. ½ or 1 unit. Prerequisite: Economics 103 or 108.

349. Senior Seminar in Labor Economics. Pre-professional capstone course intended to unify other courses in labor economics and closely related fields. Included are studies of research techniques and sources; individual readings in current literature; preparation of research reports and papers; consideration of professional employment opportunities and graduate study in labor economics and industrial relations. ½ or 1 unit. Prerequisite: Economics 240; consent of instructor. PARRISH.

350. The Developing Economies. An analysis of the economic problems associated with newly developing nations. Emphasis is placed on a study of their economic structures, their factor scarcities, and their programs for development. Not open for graduate credit for graduate candidates in economics. Graduate credit is not given for both Economics 350 and 450 or 451. ½ or 1 unit. Prerequisite: Economics 108 or 102 and 103.

352. Economic Development in Latin America. A study of economic activity and the process of diversification and industrialization in Latin America, with comparative analysis of selected countries. ½ or 1 unit. Prerequisite: Economics 103 or 108, or consent of instructor. BECKETT.

353. Economic Development in India and Southeast Asia. Analysis of plans and progress toward economic development in India and Southeast Asia; economic characteristics of the area and their significance for economic development. ½ or 1 unit. Prerequisite: Economics 103 or 108, or consent of instructor. CUMMINGS.

357. The Soviet Economy. Analytical survey of Soviet economic development; structure and performance of the economy; problems of planning and control. ½ or 1 unit. Prerequisite: Economics 103 or 108, or consent of instructor. HODGMAN.

358. The Economy of China. Discussion of changes in the patterns of production, exchange, and distribution in Communist China, with emphasis on their relation to social transformation. Survey of Chinese economic history over the past century, dealing with the institutional background to and the structure of economic activities in China. ½ or 1 unit. Prerequisite: Economics 103 or 108, or consent of instructor. SCHRAN.

360. Regional Economic Development. A survey of the theory and problems of regional economic development, including regional accounts, interregional income and trade theory, principles of the location of economic activity, theories of regional growth, and public policy for development of regions. A student receiving credit for Economics 360 may not receive credit for Economics 460 or 461. ½ or 1 unit. Prerequisite: Economics 103 or 108. NOURSE.

366. Mathematical Analysis in Economics. This course is designed to acquaint the student with the application of mathematical techniques to economic theory, especially general equilibrium theory. ½ or 1 unit. Prerequisite: Economics 103 or 108; some knowledge of calculus.

371. Sampling Theory and Technique. Design of samples useful in economic and business research. Problems considered relate to the efficiency of sample designs, cost limitations, bias, non-sampling errors, and interpretation of results. Sampling theory is applied to specific sampling problems through the use of electronic computers. ½ or 1 unit. Prerequisite: Economics 173 or equivalent.

384. Economics of Transportation. Economic aspects of the transportation industry with special emphasis on problems of regulation and public policy. ½ or 1 unit. Prerequisite: Economics 103 or 108. HARBESON.

386. Current Transportation Problems. An analytical and critical study of selected problems of current interest in transportation. ½ or 1 unit. Prerequisite: Economics 384. HARBESON.

389. Industrial Competition and Monopoly. The organization and tactics of market control, the development of antitrust law and policy, public policy regarding competitive practices, special policies applying to natural resource industries, and regulated monopoly and government ownership as alternatives to the antitrust approach. ½ or 1 unit. Prerequisite: Economics 103 or 108. HARBESON.

EDUCATION

(Including Educational Administration and Supervision, Educational Psychology, Elementary Education, History and Philosophy of Education, Secondary and Continuing Education, Special Education, and Vocational and Technical Education)

The graduate student who majors in education may specialize in administration and supervision, agricultural education, curriculum, education of exceptional children, educational psychology (including a special program in psychology of classroom learning and instruction), elementary school teaching, early childhood education, teaching of reading, guidance and counseling (including rehabilitation counseling), history and philosophy of education (including comparative education and social foundations of education), measurement and evaluation, research methods, school psychology, or any of the fields of secondary school education: English, home economics, industrial education, mathematics, modern languages, physical education, science, and social science.

Admission to graduate and professional degree work in education requires a grade-point average of 3.5 or higher and undergraduate preparation appropriate to advanced study in the chosen major. Applicants who hold bachelor's degrees in fields other than teacher education are considered on an individual basis. See admission requirements for the Master of Education.

Master of Arts or Master of Science in Education. In addition to the general rules of the Graduate College (see pages 32 to 39), the following regulations apply to programs leading to the Master of Arts or Master of Science in Education:

(1) A minimum of eight units, including a thesis of not more than two units is required.

(2) Extramural course work is not applicable toward these degrees.

(3) Competence in certain fields is required, and may be demonstrated either by satisfactory grades in required courses or by satisfactory completion of proficiency examinations on those courses. History and Philosophy of Education 304 and 305, and Educational Psychology 311 and 312 are required.

Doctor of Philosophy. To become a candidate for the Doctor of Philosophy with a major in education, the applicant must hold a master's degree with a major in education or some appropriately related subject. An applicant who has not written a master's thesis will be required to prepare and submit a paper equivalent to a master's thesis. The applicant should present credentials well in advance of his first registration. Required examinations and other steps preliminary to admission must be completed prior to the registration period. Admission is not complete until the student has been accepted by an adviser.

The general requirements of the Graduate College pertaining to the Doctor of Philosophy must be met (see pages 39 to 41). In addition to the general requirements of the College of Education, the candidate must also successfully complete, prior to the oral preliminary examination, one of the following research options: foreign language, computer science, statistics and measurement, social science methods, analytic philosophy methods, or social philosophy methods. Other options may be elected by petition to the Graduate Programs Committee of the College of Education.

PROFESSIONAL DEGREES

These degrees are designed for teachers, supervisors, administrative officers, and others engaged in educational work demanding broad, fundamental, and practical preparation and the ability to utilize professionally the contributions of research and philosophy.

Master of Education.

Admission. In addition to general requirements, the credit presented for admission must include sixteen semester hours in education with a grade-point average of 3.5 for all education courses.

Applicants holding bachelor's degrees in fields other than teacher education may be considered individually for admission to the program leading to the Master of Education. Applicants admitted with deficiencies in professional education or for teacher certification will be required to take a limited number of undergraduate courses. Such courses will not be counted in the eight units of graduate work required for the Master of Education.

In general, the professional education requirements for the Master of Education and for teacher certification may be fulfilled through proficiency examination in Educational Psychology 211, an appropriate methods course at the undergraduate level, student teaching, History and Philosophy of Education 304 and 305, and Educational Psychology 311 and 312. However, an applicant admitted with deficiencies should expect to take additional courses in the teaching subject fields.

Those preparing for teaching at the secondary level must have completed a

minimum of thirty-two semester hours of appropriate course work in the first teaching field, if elected, and from twenty to twenty-four semester hours of credit in a second teaching field. Previous course work in such fields will be evaluated and considered in determining the eligibility of a student for teacher certification.

Graduate students admitted with deficiencies for teaching in the elementary schools will be required to complete Illinois teacher certification requirements through appropriate undergraduate and graduate course work.

The advisers of students admitted with deficiencies will develop programs in which a maximum number of teacher certification requirements are met through courses also acceptable in fulfillment of master's degree requirements. Students admitted with no deficiencies can complete requirements for the Master of Education through full-time study in two semesters. However, students admitted with deficiencies for certification should anticipate from one to two additional semesters of course work.

Program. At least eight units of course work, including four units in education, are required. History and Philosophy of Education 304 and 305 and Educational Psychology 311 and 312 are required, except from students who pass proficiency examinations in these courses.

There may be one or two minors. In general, candidates for the Master of Education are expected to take at least two units in fields other than education, particularly if the specialization is in secondary education. One unit at the 300 level in the teaching subject or subjects may be substituted for one of the three units at the 400 level otherwise required. Courses at the 200 level in the teaching subject or subjects may be taken for graduate credit subject to the prior approval of the Dean of the Graduate College, but total credit in such courses may not exceed two units. Credit earned in such courses can not be applied to the requirements for the Master of Arts, Master of Science, Doctor of Education, or Doctor of Philosophy.

Residence. At least four units must be earned while the student is in residence on the Urbana campus. The residence requirement may be met by spending two eight-week summer sessions as a full-time student. Students whose employment does not allow eight weeks of summer session attendance may earn one unit while in residence for four weeks and may satisfy the residence requirement in four summer sessions of four weeks each.

Advanced Certificate in Education.

Admission. A master's degree from an accredited institution, plus a minimum of two years' successful professional employment in education are required.

Program. A year of specialized professional study is required. Of the eight units of course work required, at least four must be in courses at the 400 level. Students who have not previously taken History and Philosophy of Education 304 and 305 and Educational Psychology 311 and 312, or equivalents, must take them or pass proficiency examinations. Course work may be taken in minor subjects under regulations similar to those stated above for the Master of Education. The program must be approved by the adviser and submitted in writing to the College of Education office before the student's first registration is completed.

Credit earned by a candidate for the Advanced Certificate is not accepted as meeting requirements for the Doctor of Education or the Doctor of Philosophy.

Residence. The residence requirement is similar to that for the Master of Education.

Doctor of Education. Programs leading to the Doctor of Education are designed to provide advanced professional training and develop further ability in the scholarly study of professional problems.

Admission. A candidate for admission must hold a master's degree from an accredited institution. Applications for admission should present credentials well in advance of the date for their first registration. Admission is determined by examination, personal interviews, record of previous education and experience, and recommendation from persons who have known the candidate.

A student may transfer from the Doctor of Education program to the program for the Advanced Certificate in Education prior to the completion of five units.

Program. Sixteen units of course work beyond the master's degree are required. Extramural course work may not be included in this sixteen-unit requirement. (Exceptions may be made for Educational Psychology 413 and Educational Administration and Supervision 461, 462, and 463.) A student who has completed course work beyond the master's degree at the University of Illinois or at another accredited institution may petition for the application of not more than six units of such work toward the program leading to the Doctor of Education. A student may, with the approval of his adviser, plan a maximum of four units of work to be accomplished at other accredited institutions. A minimum of ten units must be earned in courses taken at Urbana.

History and Philosophy of Education 410 and Educational Psychology 415 and 390 are required (note prerequisites).

A preliminary examination must be passed prior to beginning the dissertation. A student must complete at least eight units of course work subsequent to his admission and must pass a comprehensive written examination before he may enter the oral preliminary examination.

Prior to admission to the preliminary examination, the student is expected to demonstrate competence in the psychology of learning, psychology of adolescence or child growth and development, psychology of adjustment or mental hygiene and the school, social psychology, social foundations of education, philosophy of education, history of American education, and comparative education. Competence may be demonstrated by satisfactory grades or by satisfactory completion of proficiency examinations.

The thesis required for the Doctor of Education may be in the area of improving professional practice and may be a field study. No academic credit is required for the thesis. General regulations of the Graduate College covering the examinations, filing of thesis titles, and the preparations, submission, and publication of theses must be met.

Residence. Minimum residence requirements are (1) two consecutive semesters, at least three units each, or (2) one semester, at least three units, and the summer session immediately preceding or following, at least one and one-half units, plus an additional summer session, at least one and one-half units.

Doctor of Education in Art Education. Doctor of Education candidates whose major field of study is art education follow programs for which the College of Education and the Department of Art share responsibility. Each student works under the joint direction of two faculty advisers, one from the College of Education and one from the Department of Art. For further information, see page 92.

Doctor of Education in Music Education. Doctor of Education candidates whose major field of study is music education follow programs of study for which the College of Education and the School of Music share responsibility. Each student works under the joint direction of two faculty advisers, one from the College of Education and one from the School of Music. For further information, see page 321.

SCHOOL PSYCHOLOGY

Students who seek specialized preparation for work as school psychologists may become candidates for either the Doctor of Education or the Doctor of Philosophy. Doctor of Philosophy candidates may major in either education or psychology, though every student who is preparing to become a school psychologist must include in his program of study extensive work in both education and psychology. The doctoral program of study for school psychologists requires a minimum of three years of graduate study plus twelve months as an intern.

A student's acceptance and his work in this program are subject to review by

the Joint Committee on School Psychology representing the College of Education and the Department of Psychology.

Students may also seek specialized preparation for work as school psychologists and be candidates for the Advanced Certificate in Education. This program, requiring two full academic years and the intervening summer session of work, more than meets the requirements of most states in preparing for the full year of internship, which usually is required for state certification at the examiner level. In addition to the work in education and psychology, courses in special education and reading are required. A master's degree can be obtained in the course of the program; the Advanced Certificate in Education is awarded at the completion of it.

SPECIAL EDUCATION

Graduate study in special education is available at the master's degree, advanced certificate, or doctoral levels. Masters' degree programs require one to two years and are designed primarily to prepare teachers of the culturally deprived, deaf, emotionally disturbed, gifted, mentally retarded, and children with learning disabilities. The Advanced Certificate requires at least a year of study beyond the master's degree and emphasizes preparation for supervision and administration of programs of special education. Doctoral programs require three or more years of advanced graduate study and are designed to prepare administrators, college instructors, and researchers in the various fields of special education indicated above. Special admission requirements apply to all graduate programs in special education. Further information concerning programs, admission requirements, and financial assistance may be obtained from the Chairman of the Graduate Selection Committee, Department of Special Education, 210 Education Building.

CLASSROOM LEARNING AND INSTRUCTION

Students planning to specialize in research and/or collegiate instruction in the educational psychology of classroom learning and instruction may become candidates for either the Doctor of Philosophy or the Doctor of Education. Doctor of Philosophy candidates major in education and minor in psychology or take a split minor with psychology and a related area, such as communications, or a subject such as mathematics, chemistry, or social studies. The program of study for the doctorate degree requires a minimum of three years of graduate study, including six months of internship. After an applicant is admitted, his study program is subject to review by one of the advisers associated with the program. A required core program consists of Educational Psychology 412, 449, 490, 492, 496, 497, and Psychology 418 and an internship of six months' minimum duration. The doctoral dissertation is generally written in the area of the nature, conditions, and improvement of classroom learning and instruction.

REHABILITATION COUNSELING

Students pursuing the Master of Education degree who plan to specialize in counseling and guidance normally require two academic years to complete this program, the fourth semester being devoted to supervised practice in an agency or institution located away from the campus. Doctoral programs also may be arranged to emphasize the study of rehabilitation counseling. Further information may be obtained from the Division of Counseling and Guidance, College of Education.

GRADUATE FACULTY

Professors: R. N. Evans (Dean of the College of Education), E. W. Anderson, R. C. Anderson, J. M. Atkin, F. P. Barnes, M. Beberman, W. C.

Becker, S. W. Bijou, G. M. Blair, H. S. Broudy, J. R. Burnett, R. W. Burnett, J. A. Easley, Jr., B. Farber, F. H. Finch, J. G. Froehlich, J. J. Gallagher, N. E. Gronlund, J. T. Hastings, P. E. Hemp, K. B. Henderson, R. A. Henderson, L. G. Humphreys, J. M. Hunt, W. P. Hurder, D. M. Jackson, R. S. Jones, M. R. Karnes, Merle B. Karnes, W. V. Kaulfers, G. C. Kettelkamp, Colleen J. Kirk, C. G. Knapp, K. M. Lansing, Celia B. Lavatelli, T. Manolakes, W. F. Marquardt, L. E. McCleary, J. E. McGill, C. J. McIntyre, W. P. McLure, L. E. Metcalf, P. E. Miller, W. J. Moore, T. E. Newland, M. M. Ohlsen, C. H. Patterson, L. J. Phipps, R. E. Pingry, S. P. Quigley, F. M. Raubinger, S. Rosen, H. A. Schultz, J. H. Shores, Elizabeth Simpson, R. H. Simpson, J. M. Slater, B. O. Smith, R. E. Spencer, B. Spodek, R. E. Stake, W. O. Stanley, M. R. Sumption, M. Tatsuoka, L. R. Tucker.

Associate Professors: T. S. Baldwin, P. G. Braunfeld, R. J. Colwell, C. B. Cox, D. J. Delaney, T. Denny, E. L. Evertts, O. E. Gould, Laura J. Jordan, H. Kaczkowski, H. H. Lerch, M. L. Maehr, Mary Mather, F. McMurray, W. R. Powell. W. L. Shoemaker, P. B. Shoresman, R. A. Smith, Hazel T. Spitze, H. J. Sredl, R. A. Tinkham, R. M. Tomlinson, K. J. Travers, J. L. Walker, C. E. Wilsey, J. S. Zaccaria.

Assistant Professors: L. Aleamoni, E. F. Anderson, B. W. Carss, F. D. Carver, R. A. Chadbourn, G. M. Clark, S. Cohen, A. J. Durant, Jo Ann Fley, L. G. Katz, K. Koenke, R. B. Lorenz, M. Masucci, R. J. Menges, H. A. Moses, T. O'Banion, M. J. Phillips, W. M. Rogge, H. G. Rowe, T. J. Sergiovanni, R. W. Walker, J. L. Wardrop, C. K. West, J. L. Wolff, Barbara A. Yates.

Educational Administration and Supervision

COURSES FOR GRADUATES

430. Elementary School Organization and Administration. Principal focus of this course is given to conceptual analyses of administrative and supervisory functions of the elementary school. Examination is made of administrative roles in the design, implementation, and improvement of the total educational program. Intensive use is made of research skills and strategies in the investigation of problems of instruction. In summer sessions this course is restricted to those without experience in administration and must be taken with Educational Administration and Supervision 464. Intended primarily for candidates for the master's degree. 1 unit. Prerequisite: Consent of instructor.

438. Instructional Supervision. Methods, theories, and research applying to supervision at all levels of public education. Analyses are made concerning the work of curriculum directors, general supervisors, special supervisors, supervising principals, and department heads. Study of supervisory methods, current plans for staff utilization, use of instructional materials, evaluation of educational programs, and evaluation of the effects of supervision are stressed. 1 unit. Prerequisite: Elementary Education or Secondary and Continuing Education 439; Educational Administration and Supervision 460. McCleary, Sergiovanni.

440. Administration and Supervision of Junior and Senior High Schools. Principal focus of this course is given to conceptual analyses of administrative and supervisory functions of the secondary schools. Problems are then projected through case studies and situational descriptions as a means of examining tasks and processes in such areas as curriculum and instruction, pupil and staff

personnel, student activities, school organization, and management and school-community relationships. In summer sessions this course is restricted to those without experience in administration and must be taken with Educational Administration and Supervision 464. Intended primarily for candidates for the master's degree. 1 unit. Prerequisite: Educational Administration and Supervision 460 or consent of instructor. McCLEARY, RAUBINGER, ROWE.

449. **Independent Study.** To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by consent of the dean. STAFF.

460. **Public Control and Administration of Education.** A course to provide the basic common understanding of theory and practice in operation and control of schools useful to teachers and other citizens. The course serves as an introductory course for prospective administrative officers and supervisors. Not open to experienced administrators nor to students who have taken any of the following courses (or equivalents): Educational Administration and Supervision 430, 440, 461, 462, 464, 465, 466. 1 unit. CARVER, MILLER, RAUBINGER, ROWE.

461. **Administration of Educational Programs and Personnel.** Study of principles and criteria for analysis of programs at various levels of operation, such as instructional departments and pupil personnel service units, individual schools, local school systems, intermediate units, state education departments, and the federal government. Similar study is given to analysis of personnel requirements at various levels of operation. Educational Administration and Supervision 461, 462, and 463 constitute the required core program for all students specializing in educational administration who are candidates for a degree beyond the master's. 1 unit. Prerequisite: Educational Administration and Supervision 460 and 430 or 440. McCLEARY, MILLER, ROWE, SERGIOVANNI.

462. **Organization and Business Administration of Public Education.** Organization and operation of public school government; functions and processes of school business administration, including internal organization of the division of business services; scope and role of the business manager, budgetary processes, accounting and financial reporting, contracts, liability, insurance, purchasing, auxiliary services, salary policies, and methods of survey, evaluation, and planning. 1 unit. Prerequisite: Educational Administration and Supervision 460, 430 or 440, and 461. McLURE, RAUBINGER, WILSEY.

463. **The Role of Administrative Leadership.** Study of principles underlying administrative leadership drawn from such disciplines as philosophy, psychology, sociology, and public administration. Application of these principles in the analysis and formulation of general procedures by which the process of administration may be carried on most effectively to develop and operate efficient educational programs. 1 unit. Prerequisite: Educational Administration and Supervision 461, and Educational Psychology 413. CARVER, McCLEARY, MILLER, ROWE, SERGIOVANNI.

464. **Field Problems in Educational Administration.** Designed to give direct experience in the study of educational problems of concern to administrators. Each student selects and pursues one or more problems of study under the supervision of a professor. 1 unit. Prerequisite: Consent of instructor. STAFF.

465. **Personnel Administration.** Principles, problems, and trends in the administration of professional public school personnel: organization of personnel; assessment and definition of personnel needs; recruitment, selection, and induction; evaluation; personnel development programs; and teacher organizations. 1 unit.

Prerequisite: Educational Administration and Supervision 460, 430 or 440, and 461. SERGIOVANNI, WILSEY.

466. Public School Finance. Advanced graduate study of the theory and technology of public school finance. Attention is centered on analysis of principles and theory underlying fiscal practice in various states; technical knowledge of designing controls, organization, and fiscal systems in harmony with expressed theory; and the application of research to the analysis of problems related to the improvement of financing public schools. 1 unit. Prerequisite: Educational Administration and Supervision 462 or consent of instructor. MCLURE.

468. School-Community Relations. Study of the relationship of the American school to the community. Analysis of the power structure, social agencies, school liaison groups, and economic character of the community as they affect and are affected by the school. Includes an evaluation of the various media of communication between the school and the larger community, and the development of criteria for an effective program of school-community relations. 1 unit. SUMPTION.

469. Legal Basis of School Administration. The legal rights, privileges, responsibilities, immunities, and authority of pupil, parents, teachers, administrators, and school board members in relation to the school. 1 unit. SUMPTION.

470. Principles and Resources for School Plant Planning. Study of principles for planning functional school buildings. Primary emphasis is placed on the planning process involved in meeting the building needs of the school district, including (1) analysis and projection of educational programs to be housed, (2) prediction of pupil enrollments, (3) site selection, (4) educational specifications of buildings, and (5) rehabilitation, remodeling, and modernization of existing buildings. 1 unit. Prerequisite: Educational Administration and Supervision 460. WILSEY.

490. Seminar for Advanced Students of Education. Seminar in educational administration and supervision open only to persons who have been admitted for doctoral study in educational administration and supervision. 1 to 2 units. STAFF.

491. Field Study and Thesis Seminar. Usually required of candidates for the Doctor of Education. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to Ed.D. candidates. 1 to 2 units. STAFF.

499. Thesis Research. Individual direction of research and thesis writing. 0 to 4 units. STAFF.

Educational Psychology

COURSES FOR GRADUATES

411. Psychology of Adolescence for Teachers. The psychological significance of adolescence, its biological and social foundations, and its implications for education. 1 unit. Prerequisite: Educational Psychology 311 and 312. BLAIR, JONES, WEST, ZACCARIA.

412. Advanced Child Development for Students of Education. A consideration of the nature of the child and his development during the preschool and elementary school years, with emphasis on development as a process of social learning;

interpretation of the scientific literature as it concerns the educative process; discussion of methods of studying and evaluating the behavior of the child as an individual and in group situations. 1 unit. Prerequisite: Educational Psychology 311 and 312. COHEN, JONES, WOLFF.

413. **Social Psychology and the Problems of Education.** A consideration of the concepts and methods of social psychology as they apply to the professional functions of teachers, administrators, and other persons engaged in education. Opportunity to work upon field problems is provided. 1 unit. Prerequisite: Educational Psychology 311, 312, and 390. MAEHR, R. H. SIMPSON.

414. **The Psychology of College Teaching.** Designed particularly for graduate students minoring in education or preparing for college teaching. Psycho-educational problems in undergraduate and graduate teaching, with special emphasis upon individual differences, remedial procedures, principles of learning, the technology of teaching and learning, adjustment problems of college students, counseling and advisory services, test construction, analysis and use of test results and resource materials in this field. 1 unit. Prerequisite: A course in psychology; consent of instructor. MENGES, R. H. SIMPSON.

415. **Psychological Theories Applied to Education.** An advanced course in human behavior required of all candidates for the degree of Doctor of Education. Special attention is given to contemporary systems of psychology and their relationship to educational practice. 1 unit. Prerequisite: Educational Psychology 311 and 312; Educational Psychology 411 or 412; candidacy for Ed.D. or Ph.D. in Education. BLAIR, JONES, MAEHR.

422. **Basic Principles of Counseling.** Study of counseling processes that are especially applicable to the problems of normal individuals. Theories of education and personality which underlie counseling procedures are studied for the purpose of developing the student's ability to evaluate these procedures. 1 unit. Prerequisite: Educational Psychology 311 and 312. DELANEY, KACZKOWSKI, LONG, OHLSEN, SHOEMAKER, SLATER.

423. **The Use of Tests in Guidance.** Practice in interpreting test results in case studies; study of the implications on test choices and usage of the philosophic orientation of the counselor, the type of case, the case setting, and the case information available; discussion of the advantages and disadvantages of particular tests for given types of cases. 1 unit. Prerequisite: Educational Psychology 390, 392, and 422, or equivalents. HASTINGS, KACZKOWSKI, PATTERSON, PHILLIPS.

424. **Supervised Practice in Counseling.** Study of the individual client through the use of the tools of the counselor. Each student is expected to develop professional skills by working with clients. 2 units. Prerequisite: Master's degree in guidance; consent of faculty committee. STAFF.

425. **Principles of Guidance.** For teachers, administrators, student advisers, and others who are interested in basic guidance principles and in guidance methods useful to schools and to agencies dealing with out-of-school youth and adults. Considers the role of guidance specialists and the guidance functions of community agencies. Students who have taken Educational Psychology 325 are not given credit for Educational Psychology 425. 1 unit. STAFF.

427. **Principles and Techniques of Group Guidance.** A study of the principles of group guidance and their application. Includes a review of the historical development of group guidance and the study of pertinent research. Discussion and role playing have an important part in the work of the course. Case materials are utilized. 1 unit. Prerequisite: Educational Psychology 311, 312, 422, 423, and either 325 or 425; or consent of instructor. KACZKOWSKI, LONG, MASUCCI, OHLSEN.

428. The Analysis and Use of Occupational Information in Guidance Programs. Deals with the results of recent occupational research and with the use of these results by teachers and counselors. Attention is given to research techniques suitable for use in local occupational studies. 1 unit. Prerequisite: Educational Psychology 425 or an introductory course in counseling. KACZKOWSKI, MASUCCI, OHLSEN, SHOEMAKER, ZACCARIA.

429. Field Instruction in Counseling. Individual instruction designed to help the advanced student apply the basic principles of counseling. Each student is assigned to a counseling agency. 1 or 2 units. Prerequisite: Educational Psychology 422 and 424 (with consent of instructor, registration in Educational Psychology 424 may be concurrent). STAFF.

447. Seminar in Rehabilitation Counseling. Problems of rehabilitation, including problems associated with specific physical and mental disabilities. Critical examination of literature pertaining to rehabilitation, with emphasis on recent publications. May be repeated for a maximum of one unit. ½ unit. Prerequisite: Educational Psychology 326 and 422. MOSES, PATTERSON.

449. Independent Study. To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by consent of the dean. STAFF.

490. Seminar for Advanced Students of Education. Seminar in educational psychology open only to persons who have been admitted for doctoral study in educational psychology. 0 to 2 units. STAFF.

491. Field Study and Thesis Seminar. Usually required of candidates for the Doctor of Education. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to Ed.D. candidates. 1 to 2 units. STAFF.

492. Psychology of Learning and Instruction. Same as Psychology 492. An advanced course in the nature and conditions of long-term cognitive learning and retention in classroom and similar situations. This course is intended for doctoral students with a special interest in research leading to the improvement of classroom teaching and learning, in psychological aspects of curriculum research, and in the cognitive aspects of military and industrial training. 1 unit. Prerequisite: Consent of instructor. ANDERSON, WOLFF.

494. Multivariate Analysis in Psychology and Education. Same as Psychology and Sociology 494. The principal methods of descriptive statistics used in the analysis of multiple measurements, with emphasis on conventional procedures of factor analysis; profile similarity models; discriminatory analysis; multi-dimensional scaling. 1 unit. Prerequisite: Psychology 307 or Educational Psychology 496; consent of instructor. TUCKER, WARDROP.

495. Theory of Measurement. Same as Psychology 495. Logical and mathematical principles underlying test design, construction, and validation, with particular emphasis on evaluating reliability of measurement, utility resulting from test-based decisions, and validity of descriptions of individuals. 1 unit. Prerequisite: Educational Psychology 496 or Psychology 307, or equivalent; Educational Psychology 392 or Psychology 290, or equivalent. STAKE, TUCKER, WARDROP.

496. Statistical Methods in Education. First graduate course in statistical methods in education. Includes an introduction to the logic of scientific method in education; probability and sampling in education, correlation methods in educational measurements and research; partial and multiple correlation and the testing of statistical hypotheses; and other applications of statistics to educational research. 1 unit. Prerequisite: Educational Psychology 390. ALEAMONI, CHADBOURN, PINGRY, STAKE, TATSUOKA.

497. Advanced Statistical Methods in Education. An advanced course in statistical methods applied to educational research. Analysis of variance and co-variance, experimental design, introduction to multivariate statistical techniques including discriminant analysis. 1 unit. Prerequisite: Educational Psychology 496. TATSUOKA.

498. Theory of Educational Evaluation. Study of relationship between educational purposes, curriculum, and evaluation through emphasis on principles of evaluation dealing with classifications of behavior. A detailed study of the concept of test validity, of its determination, and of its relation to test design, with emphasis on the evaluation of outcomes involving the higher mental processes. Guided practice in solving complex problems of evaluating behaviors, some in subject matter areas but primarily those cutting across subject matter lines. 1 unit. Prerequisite: Educational Psychology 496. HASTINGS, SPENCER, STAKE.

499. Thesis Research. Individual direction of research and thesis writing. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. Psychology of Learning for Teachers. A consideration of learning situations in the light of psychological findings and concepts. Development of a theory of learning, and its application to the teaching of attitudes, skills, and understanding. ½ unit. Prerequisite: Educational Psychology 211; practice teaching or teaching experience. STAFF.

312. Mental Hygiene and the School. An examination of social and emotional adjustment. Study of normal personality, integration, feelings of inferiority, adjustment mechanisms, classroom therapy, behavior disorders in children, and introduction to methods of child study and provision for emotionally disturbed children. ½ unit. Prerequisite: Educational Psychology 211; practice teaching or teaching experience. STAFF.

313. Programmed Instruction. The design, production, and evaluation of self-instructional materials, including delineation of objectives, task analysis, frame writing, frame editing, pilot testing and revision, and field testing; survey of current research and orientations toward programmed instruction; consideration of the mechanized and text forms for presenting programs. Each student prepares a self-instructional program. 1 unit. Prerequisite: Educational Psychology 311. ANDERSON.

326. Introduction to Vocational Rehabilitation Counseling. A survey of the history and development of vocational rehabilitation programs; contributions of related disciplines and their integration; basic procedures and problems of vocational rehabilitation counseling. ½ unit. Prerequisite: Consent of instructor. MOSES, PATTERSON.

339. Corrective Reading. Same as Elementary Education 339. Practice in administering and interpreting group diagnostic reading tests; instructional techniques appropriate for less severe reading disabilities. 1 unit. Prerequisite: Elementary Education 336 or 338. BENNETT, POWELL.

343. Individual Intelligence Testing. The fundamental concepts relevant to the general problem of the individual testing of learning aptitude. Acquisition of

psychometric competence in the use of the 1960 Binet and the Wechsler tests. Acquaintance and limited practice in the administration, scoring, and interpretation of results obtained by means of performance scales and other devices appropriate for use with individuals having sensory, associative, and/or motor impairments. 1 unit. Prerequisite: Consent of instructor and six hours of psychology; Special Education 324 or Educational Psychology 392 or Psychology 390, or equivalent. NEWLAND, PHILLIPS.

360. **Educational Uses of Television and Radio.** Same as Communications and Radio-Television 360. A study of television and radio as educational instruments, and standards necessary for such use; production, utilization, planning, and evaluation; primary and secondary uses. Identification of the unique contributions and resources of the electronic media, as well as their limitations. Experimentation into new production and utilization techniques designed for educational uses. ½ unit. MCINTYRE, SKORNIA.

390. **Elements of Educational Statistics.** Designed for terminal value for professional training of students not intending to pursue advanced graduate work, and for introductory value for students continuing graduate study in education. The course includes descriptive statistics, introduction to correlation and regression, the normal curve, statistical inference, and the presentation and interpretation of statistical data in educational literature. 1 unit. Prerequisite: Educational Psychology 211 or 236. ALEAMONI, CHADBOURN, HASTINGS, PINGRY, STAKE, TATSUOKA.

391. **Construction and Use of Tests in Teaching.** Includes the relationship of classroom testing to educational objectives and the curriculum; the construction, administration, and scoring of the various types of essay and short-answer tests; and other means of measuring the attainment of objectives and marking procedure. Designed primarily for classroom teachers. 1 unit. Prerequisite: Educational Psychology 211 or 236. GRONLUND, HASTINGS, SPENCER.

392. **Introduction to the Principles of Measurement.** Study of the selection, preparation, administration, and interpretation of psychological and educational tests and diagnostic devices, with emphasis on theory at a beginning level and with application to hypothetical school situations as a teaching device. Sources of standard tests, criteria for their evaluation, methods of scoring, interpretation, and general and special areas are considered. 1 unit. Prerequisite: Educational Psychology 211 or Elementary Education 236. GRONLUND, HASTINGS, KACZKOWSKI, SPENCER, STAKE.

Elementary Education

COURSES FOR GRADUATES

431. **Elementary School Classroom Programs.** An exploration of organizational centers for determining selection and sequence of educative experiences in the elementary school classroom. The role of the teacher in curriculum construction is emphasized. 1 unit. STAFF.

432. **Clinical Diagnosis and Remediation in Reading.** Supervised experience in the Reading Center; special attention is given to evaluative and interpretative techniques in cases of severe reading disabilities based on the analysis of specific reading needs. May be repeated for a maximum of 2 units of credit. 1 unit. Prerequisite: Elementary Education 339 and a course in individual mental testing. POWELL.

433. **Curriculum Problems and Trends in Special Fields of Elementary Education.** A study of the place of the various special fields of elementary education in the

emerging elementary school curriculum, with a review and analysis of recent trends and research findings in these fields. Sections are usually offered in the following fields: (a) language arts, (b) social studies, (c) mathematics, (d) science, (e) creative arts, (f) reading, (g) early childhood education, (h) teacher education. 1 unit. Prerequisite: For all sections, Elementary Education 431 or 434, or consent of instructor; for the section in language arts, Elementary Education 333 and 336, or a course in the teaching of reading or language arts, or consent of instructor; for the section in creative arts, Elementary Education 337 or consent of instructor; for the section in science, Elementary Education 335 or a methods course in teaching science in the elementary school and two years of college science, or consent of instructor; for the section in reading, Elementary Education 336 or a course in teaching of reading: for the section in early childhood education, Elementary Education 434 or consent of instructor. STAFF.

434. **Programs in Early Childhood Education.** An advanced course intended primarily for teachers and supervisors of younger children, ages three to eight. Presents a review and analysis of research findings, experimentation, and current trends in curriculum organization, procedures, and materials essential to developing classroom programs for children. 1 unit. KATZ, LAVATELLI, SPODEK.

435. **Diagnosis and Correction in Elementary Mathematics.** The nature, causes, and correction of mathematical difficulties at the elementary level; process of evaluation through group and individual procedures; the development and use of diagnostic instruments and corrective techniques; supervised experience with pupils having difficulties. 1 unit; may be repeated for a maximum of 2 units. Prerequisite: Elementary Education 332; Educational Psychology 392; or equivalent.

436. **Field Instruction in Reading Programs.** Provides for directed practice in the area of reading; students are placed in an approved and supervised field position for part of the semester. 1 unit. Prerequisite: Elementary Education 432.

437. **Methods of Child Study.** A study of ways in which teachers can evaluate child behavior and development. Particular emphasis is placed on classroom application. Instruction and practice in the use and interpretation of observations, anecdote records, rating scales, interviews, achievement tests, intelligence tests, questionnaires, sociometric and projective techniques. 1 unit. Prerequisite: Educational Psychology 312 or consent of instructor. KATZ, LAVATELLI, SPODEK.

438. **The Organization and Supervision of School Reading Programs.** Study of procedures for planning, improving, and evaluating reading programs on a systemwide basis. Open only to those persons who are preparing to supervise reading programs or with approval of graduate adviser. 1 unit. Prerequisite: Elementary Education 339 or Educational Psychology 339; Elementary Education 433 (reading section) . POWELL.

439. **Fundamentals of Curriculum Development.** Designed to explore and clarify the several theoretical bases offered in educational literature for each of the major aspects of curriculum planning, to indicate the forms implementation of these theories have assumed in practice, to reduce these theoretical and practical differences to fundamental issues, to encourage critical evaluation of both the theories and practices from the standpoint of logical and empirical evidence, and to project, on the basis of such analysis, needed research, present best practice, and ultimately desirable programs. 1 unit. MCGILL, SHORES.

449. **Independent Study.** To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which

appropriate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by special consent of the dean. Prerequisite: Approval of study outline by adviser and the department chairman prior to enrollment. STAFF.

455. **Theories of Art Education.** A study of the major theories of art education and an analysis of the most significant research in the field. Emphasis is given to a critical evaluation of theory and research and to the application of such studies to current problems in art education in the public schools. 1 unit. Prerequisite: Elementary Education 337 or Secondary and Continuing Education 456, or consent of instructor. LANSING.

459. **Workshop in Curriculum Development.** Curriculum development projects in specialized fields of elementary education. 1 to 2 units. STAFF.

490. **Seminar for Advanced Students of Education.** Seminar in elementary education open only to persons who have been admitted for doctoral study in elementary education. 1 to 2 units. STAFF.

491. **Field Study and Thesis Seminar.** Usually required of candidates for the Doctor of Education. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to Ed.D. candidates. 1 to 2 units. STAFF.

499. **Thesis Research.** Individual direction of research and thesis writing. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

332. **Principles and Practices in Elementary Mathematics Education.** Organization, scope, and sequence of the elementary mathematics program and the functional nature of mathematics; methods, techniques, experiences, and materials of value in teaching elementary mathematics, and the role of the classroom teacher. ½ or 1 unit. Prerequisite: Mathematics 202 and 203 or equivalent. LERCH.

333. **The Teaching of Language Arts in the Elementary School.** Concerns itself with goals, content, and teaching problems involved in the devising of programs in the area of elementary school language arts that are cumulative and sequential from kindergarten through the elementary school. ½ to 1 unit. Prerequisite: Elementary Education 237; Educational Psychology 236. EVERTTS, MOORE.

334. **Principles and Practices in Early Childhood Education.** A study of the practices and principles of using play as an educational tool in early childhood education; presents a review of historical, philosophical, and psychological foundations of nursery-kindergarten methods, assesses techniques relating play to various aspects of instruction, surveys materials and equipment, and presents methods of classroom evaluation. ½ unit. Prerequisite: Elementary Education 237. KATZ, SPODEK.

335. **Science in the Elementary School.** The principles, place, and practice of science education in the elementary school and in the lives of children. The course stresses the functional nature of science and its place in the curriculum. Consideration is given to the organization of the science program, experiences, and techniques of value in teaching and of the role of the clasroom teacher and the specialist. Opportunity for experience in field and laboratory work. ½ unit. Prerequisite: Elementary Education 237 or equivalent; two years of college science. ATKIN, R. W. BURNETT, SHORESMAN.

336. Primary Reading. Basic principles, techniques, and materials for the developmental reading program in the primary grades. Emphasis is placed on methods and materials which provide for differentiated instruction. ½ or 1 unit. Prerequisite: Junior standing; registration in a teacher education curriculum. DURKIN, MOORE, POWELL, SHORES.

337. Art Education in the Elementary School. Methods, plans, and materials for teaching art as an integral part of the total educational program in the elementary school. ½ unit. Prerequisite: Junior standing. LANSING, SCHULTZ.

338. Teaching of Reading in Grades Four Through Twelve. Same as Secondary and Continuing Education 338. Developmental reading programs beyond the primary grades. Factors related to reading speed and comprehension; vocabulary development, specific comprehension skills, study skills, reading interests and tastes. ½ or 1 unit. Prerequisite: Elementary Education 336 or Educational Psychology 211. ERICKSON, POWELL, WALKER.

339. Corrective Reading. Same as Educational Psychology 339. Practice in administering and interpreting group diagnostic reading tests; instructional techniques appropriate for less severe reading disabilities. 1 unit. Prerequisite: Elementary Education 336 or 338. POWELL.

354. Audio-Visual Communication. Same as Secondary and Continuing Education and Library Science 354. An analysis and application of those introductory aspects of communication theory and practices concerned with the design and use of audio-visual messages which influence the learning process. This course is also concerned with selection, utilization, production, and evaluation of audio-visual materials and selected technological aids. ½ or 1 unit. Prerequisite: Senior or graduate standing. LORENZ.

History and Philosophy of Education

COURSES FOR GRADUATES

400. Problems of Educational Theory. Analysis of the kinds of problems encountered in constructing an educational theory, and of relations between educational theory and other disciplines, especially philosophy and the social sciences. 1 unit. Prerequisite: History and Philosophy of Education 301 or 305. MCMURRAY.

401. Modern Theories of Education. A critical analysis and examination of the theories of education represented by the work of Robert M. Hutchins, Henry C. Morrison, the Harvard Committee, and William H. Kilpatrick. 1 unit. STANLEY.

402. Educational Movements in the Twentieth Century. An historical study of significant educational trends during the past sixty years, with special reference to their influence on American education; an analytical examination of the principal transition movements in the last decade of the nineteenth century and of efforts to solve the problems since 1900. 1 unit. Prerequisite: Consent of instructor. TYACK.

403. The Historical Foundations of American Educational Thought. A study of the evolution of educational theories and philosophies since the eighteenth century, with particular reference to their impact upon educational developments in the United States. Effort is made to give a broad view of the general growth of American educational thought, with sufficient time devoted to selected major educational theorists, or schools of thought, to permit adequate exploration of their fundamental ideas and the relation of these ideas to significant intellec-

tual currents in American culture. 1 unit. Prerequisite: Consent of instructor. TYACK.

404. Seminar in Educational Classics. Reading and group discussion of a limited number of the most important writings in educational philosophy which have had a profound influence on the progress of educational thought and practice. 1 unit. Prerequisite: One graduate course in philosophy of education and one in history of education, or consent of instructor. BROUDY.

405. Foundations of Aesthetic Education. A philosophical approach to the problems of teaching for appreciation in formal education. Appraisal of the status of aesthetic education, its nature and function, and its relation to other types of education are the major areas investigated. 1 unit. Prerequisite: History and Philosophy of Education 306 or consent of instructor. BROUDY.

406. Seminar in the History of Education. Intensive group study of a small number of selected problems to assist individual students to develop an understanding of and the ability to use the techniques of historical research in furthering such study. Problems studied in any one semester are selected in the light of the interests and previous training of the group of students enrolled. 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Two courses in the history of education and one course in the philosophy of education, or consent of instructor. TYACK.

407. Logical Foundations of Methods. A study of the application of principles of logic in methods of instruction. This study involves the treatment of the problems of educational direction and control in processes of inference, judgment, and knowing, examined from the standpoint of recent developments in pragmatism. 1 unit. Prerequisite: Consent of instructor. MCMURRAY.

408. Advanced Philosophy of Education. A systematic exploration of knowledge and inquiry as they relate to problems of formulating educational policy, curriculum design, organization of the school system, and teaching-learning. Selected materials in the history of epistemology are examined and emphasis is placed on a critical appraisal of significant trends in educational theory: 1 unit. Prerequisite: History and Philosophy of Education 301 or 305 or advanced graduate standing; consent of instructor. BROUDY, J. R. BURNETT, STANLEY.

409. Advanced Philosophy of Education. A study of the nature of value as it relates to problems of formulating and justifying educational aims and policies, curriculum design, organization of the school system, and teaching-learning. Selected materials in ethics, value theory, and aesthetics are used in the critical appraisal of significant trends in educational theory. 1 unit. Prerequisite: History and Philosophy of Education 301 or 305 or advanced graduate standing; consent of instructor. BROUDY, J. R. BURNETT, STANLEY.

410. Seminar in Theories of Educational and Social Change. Designed to help prospective educational leaders acquire an understanding of current theories of social change as these relate to the work of the profession of teaching. There is now an extensive body of knowledge on the nature and control of social change. This needs to be made available to all prospective educational leaders in order that they may go about their duties with greater understanding and skill. Designed to aid students in bringing this knowledge to bear upon the problems of leadership in educational and social change. 1 unit. Prerequisite: Candidacy for Ed.D. or Ph.D. in education. BROUDY, J. R. BURNETT, FEINBERG, B. O. SMITH, STANLEY.

449. Independent Study. To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which

appropriate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by consent of the dean. STAFF.

483. Methods in Comparative Education. Methodologies and concepts involved in comparative educational systems in selected countries; topics related to the role of normative, institutional, and environmental patterns in shaping educational policies related to administration, curriculum development, diversification and expansion of educational opportunity. 1 unit. Prerequisite: Anthropology 373 or Sociology 300, History and Philosophy of Education 303 or 386, or consent of instructor. PESHKIN, YATES.

484. Education in the Industrialized Nations. An examination of education and national policy in industrialized nations. Topics include education and political integration, socialization, economic growth and manpower development, social status and mobility, and educational planning. Particular attention is given Western Europe, the U.S.S.R., and North America. 1 unit. Prerequisite: History and Philosophy of Education 303 or 386, or consent of instructor. YATES.

485. Education in the Developing Countries. An analysis of the role and functions of education in social, political, and economic development, with particular reference to the new and the developing countries. 1 unit. Prerequisite: History and Philosophy of Education 303 or 386, or consent of instructor. PESHKIN, YATES.

490. Seminar for Advanced Students of Education. Seminar in history and philosophy of education open only to persons who have been admitted for doctoral study in history and philosophy of education. Sections are usually offered in the following fields: (a) history of education, (b) philosophy of education, (c) comparative education, (d) social foundations of education. 1 to 2 units. Prerequisite: For section (c) only, History and Philosophy of Education 483 or consent of instructor. STAFF.

491. Field Study and Thesis Seminar. Usually required of candidates for the Doctor of Education. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to Ed.D. candidates. 1 to 2 units. STAFF.

499. Thesis Research. Individual direction of research and thesis writing. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. The History of Education. Brief introductory survey of ancient and medieval education followed by a more extended study of educational developments since the Italian Renaissance. Special emphasis on the relation of educational trends to broader social, economic, political, and intellectual movements. ½ unit. TYACK.

301. Philosophy of Education. Based on Dewey's *Democracy and Education,* this course is an examination of experimentalist philosophy in its bearings on educational problems; nature and aims of education in a democratic society; relation of the individual to society; interest and discipline; play and work; freedom and control; subject matter and method. ½ unit. J. R. BURNETT, MCMURRAY, STANLEY.

302. History of American Education. The development of American education in relation to political, social, and cultural developments. Special attention is

given to the influence of movements in the cultural environment upon evolving conceptions of educational theory and practice. ½ unit. TYACK.

303. Comparative Education. A study of selected national systems of education in their differing cultural settings. ½ unit. PESHKIN, YATES.

304. Social Foundations of Education. An introductory survey of the interrelationship between school and society and of the impact on public education of the major social trends and forces operating in our society. ½ unit. J. R. BURNETT. DIEKMA, FEINBERG, B. O. SMITH, STANLEY.

305. History of Educational Ideas. Through a study of selected educational theorists and intellectual movements, this course provides familiarity with the major educational ideas of the past, as well as historical perspectives on current issues and problems in education. Readings in Plato, Quintilian, St. Augustine, Loyola, Comenius, Rousseau, Pestalozzi, Froebel, Herbart, Dewey, and others. ½ unit. FEINBERG, MCMURRAY, TYACK.

306. Introduction to Aesthetic Education. A philosophic introduction to the problems of teaching for critical judgment and appreciation. Materials from aesthetics, art history, and criticism are examined for their relevance to the problems of aims, curriculum, organization, and teaching-learning, with special attention to problems of interrelated arts and humanities programs. Designed for prospective teachers of art, music, literature, and related subjects. ½ or 1 unit.

315. Sociology of Education. Same as Sociology 315. Objective comparative study of education as a social process in various cultures and historical periods, with main emphasis on present education in countries which share Western civilization. ½ or 1 unit. Prerequisite: Sociology 100, or 104 and 105, or 151 and 152.

385. The Anthropology of Education. Same as Anthropology 385. Introduction to the contribution of anthropology to the cross-cultural study of education; includes illustrative material from representative cultures ranging from primitive social groups to present-day national states; emphasis is on education as a cultural process in relation to culture change and cultural development. ½ to 1 unit. Prerequisite: A course in anthropology or sociology, or consent of instructor.

386. Education and International Relations. An analysis of the role of education in international relations. Emphasizes the policies and programs of the major aid-giving nations, the competition among these nations, and the results of foreign assistance programs in the developing countries. ½ to 1 unit. Prerequisite: History and Philosophy of Education 303 or consent of instructor. PESHKIN.

Secondary and Continuing Education

COURSES FOR GRADUATES

439. Fundamentals of Curriculum Development. Designed to explore and clarify the several theoretical bases offered in educational literature for each of the major aspects of curriculum planning, to indicate the forms implementation of these theories have assumed in practice, to reduce these theoretical and practical differences to fundamental issues, to encourage critical evaluation of both the theories and practices from the standpoint of logical and empirical evidence, and to project, on the basis of such analysis, needed research, present best practice, and ultimately desirable programs. 1 unit. STAFF.

441. Linguistic and Logical Analysis of Teaching. An analysis of teaching from the standpoint of semantic and logical factors. Topics such as theories of meaning,

definition, explanation, and justification as employed by a teacher are discussed. 1 unit. K. B. HENDERSON.

448. **Continuing Education.** Development, status, and prospects of continuing education for adults. Institutions, agencies, and programs; public policy and policy-making for continuing education; organization, administration, finance, and promotion; recruiting, training, and supervising staff; planning programs and courses; the literature of continuing education. Systematic study of individual problems supplements class work. ½ or 1 unit. PHIPPS.

449. **Independent Study.** To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by consent of the dean. STAFF.

456. **Problems and Trends in Specialized Fields of Secondary Education.** This course introduces the student to significant problems, points of view, and trends in the field concerned. Significant research relating to organization, content, and techniques in the field in question is explored. Students are encouraged to make special studies in approved areas. 1 unit. Sections are usually offered in the following fields:
(a) **English.** ERICKSON, MADSEN, MARQUARDT, WALKER.
(b) **Foreign Languages.** DAIGH, KAULFERS, KETTLEKAMP.
(c) **Mathematics.** K. B. HENDERSON, PINGRY, TRAVERS.
(d) **Science.** R. W. BURNETT, GOULD, WELLER.
(e) **Social Science.** COX, METCALF.
(f) **Physical Educaton.** KNAPP.
(g) **Music.** COLWELL.

459. **Workshop in Curriculum Development.** Curriculum development projects in specialized fields of secondary and continuing education. 1 to 2 units. STAFF.

467. **The American College.** Development of the American college and university; higher education processes, organization, and administration; the variety of problems and conflicting theories; policies, practices, and present trends. 1 unit. FLEY.

490. **Seminar for Advanced Students of Education.** Open only to persons who have been admitted for doctoral study in secondary and continuing education. Sections are usually offered in the following fields: (a) English, (b) foreign languages, (c) mathematics, (d) science, (e) social studies, and (f) general secondary curriculum. 1 to 2 units. STAFF.

491. **Field Study and Thesis Seminar.** The purpose of this seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of the three stages in its development: (1) tentative design stage; (2) revised design stage; (3) final design stage. Limited to Ed.D. candidates. 1 to 2 units. STAFF.

499. **Thesis Research.** Individual direction of research and thesis writing. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

338. **Teaching of Reading in Grades Four Through Twelve.** Same as Elementary Education 338. Developmental reading programs beyond the primary grades. Factors related to reading speed and comprehension; vocabulary development, specific comprehension skills, study skills, reading interests and tastes. ½ or 1

unit. Prerequisite: Elementary Education 336 or Educational Psychology 211. Erickson, Walker.

354. **Audio-Visual Communication.** Same as Elementary Education and Library Science 354. An analysis and application of those introductory aspects of communication theory and practices concerned with the design and use of audio-visual messages which influence the learning process. This course is also concerned with selection, utilization, production, and evaluation of audio-visual materials and selected technological aids. ½ or 1 unit. Prerequisite: Senior or graduate standing. Lorenz.

356. **The Computer and Mathematics Education.** Surveys the role of the computer as an educational tool with an emphasis on applications for teaching precollege mathematics. Analysis of computational problems and development of algorithms for their solution; iteration, nonlinear interpolation, and Monte Carlo methods; computer-assisted instruction; individually prescribed instruction; modular scheduling; information retrieval; library programs; natural language analysis. 1 unit. Prerequisite: Computer Science 101, 400, or consent of instructor.

Special Education

COURSES FOR GRADUATES

416. **Problems in Mental Deficiency.** An advanced course in mental deficiency, covering definitions, theories, classifications, etiology, diagnosis, and social, medical, psychological, and educational rehabilitation procedures. Emphasis is on the contributions of biology, sociology, anthropology, and psychology to educational theory and practice with reference to the mentally deficient. 1 unit. Prerequisite: Special Education 322 or consent of instructor. Salvia.

417. **Psycho-Educational Problems of Exceptional Children.** A course for educators, students in the behavioral sciences, and students beginning graduate study in special education. Study of relevant research dealing with the physical, mental, emotional, and social traits of all types of exceptional children and consideration of major current problems in the development of educational programs. 1 unit. Prerequisite: Sixteen hours of psychology and/or education or consent of instructor. Staff.

418. **Communicative Problems of the Deaf.** An advanced course in the problems and procedures involved in the acquisition of language and communication by persons with severe hearing impairment, particularly those with profound prelingual deafness. Emphasis is placed on research and measurement in the development of speech, speechreading, residual hearing, reading, written language, and manual communication, including finger spelling and the language of signs. The applications of recent approaches in linguistics and psycholinguistics to language development are stressed. 1 unit. Prerequisite: Consent of instructor. Quigley.

419. **Diagnosis of Learning Disabilities.** A course covering the advanced theory and technology of learning disabilities with special reference to etiology and diagnosis. The main emphasis is on the psychoneurological, genetic, and psycholinguistic aspects of reading disorders. Remediation which is implicit in diagnostic procedure is also covered. Laboratory practice is required. This is the first half of a year's sequence with Special Education 444. 1 unit. Prerequisite: Special Education 318 (b) ; Psychology 443 or Educational Psychology 343; consent of instructor. Chalfant.

420. **The Social Psychology of the Handicapped.** A study of the social and emotional adjustment of handicapped children and adults, and of the somato-psychologi-

cal significance of mental, sensory, and motor variations in the adjustive process. The effects of limitations imposed by the attitude of society, the attitude of the individual toward his handicap, and the handicap itself are evaluated. Implications for current educational programs for the handicapped are analyzed. 1 unit. Prerequisite: Special Education 117 or 417 and Educational Psychology 312, or consent of instructor. NEWLAND.

421. Administration and Supervision of Special Education. Designed for advanced graduate students preparing for administrative or supervisory positions in special education programs. Administrative and supervisory practices in educating exceptional children are examined with emphasis on special education programs in the public schools; application of administrative theory to special education programs. Field trips to observe and evaluate programs are required. 1 unit. Prerequisite: Special Education 417; Educational Administration and Supervision 460; consent of instructor. CHALFANT, R. A. HENDERSON, M. B. KARNES.

444. Remediation of Learning Disabilities. The course covers the theory and practice of remediation of children with learning disabilities, with emphasis on matching a wide variety of methods to specific deficits. Advanced diagnostic procedures and teaching, prescription writing, and evaluative monitoring are covered. The course includes supervised clinical practice. 1 unit. Prerequisite: Special Education 318 (b) and 419. CHALFANT.

449. Independent Study. To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by consent of the dean. STAFF.

456. Problems and Trends in Special Education. Introduces the student to significant problems, points of view, and trends in the field concerned. Significant research related to organization, content, and techniques in the field in question is explored. Students are encouraged to make special studies in approved areas. Sections may be offered in the following fields: (a) mental retardation, (b) learning disabilities, (c) gifted children, (d) deaf children, (e) emotionally disturbed children, (f) programmed learning for exceptional children, (g) culturally disadvantaged children, and (h) administration. 1 to 2 units. Prerequisite: Consent of instructor. STAFF.

459. Workshop in Curriculum Development. Curriculum development projects in specialized fields of special education. Sections may be offered in the following fields: (a) mental retardation, (b) learning disabilities, (c) gifted children, (d) deaf children, (e) emotionally disturbed children, (f) programmed learning for exceptional children, (g) culturally disadvantaged children, and (s) pre-school. 1 to 2 units. STAFF.

490. Seminar for Advanced Students of Education. Seminar in the education of exceptional children open only to persons who have been admitted for doctoral study. Sections may be offered in the following fields: (a) mental retardation, (b) learning disabilities, (c) gifted children, (d) deaf children, (e) emotionally disturbed children, (f) programmed learning for exceptional children, (g) culturally disadvantaged children, (h) administration, (u) behavior modification, and (x) special education. 1 to 2 units. STAFF.

491. Field Study and Thesis Seminar. Usually required of candidates for the Doctor of Education. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception,

delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to Ed.D. candidates. 1 to 2 units. STAFF.

499. **Thesis Research.** Individual direction of research and thesis writing. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

316. **The Gifted Child in School and Society.** A consideration of the gifted in society: who they are, their physical, psychological, social, and educational characteristics, and society's needs and provisions for them. The major portion of the course is devoted to the consideration and evaluation of instructional and administrative adjustments that should be made for the gifted in the educational structure. ½ to 1 unit. Prerequisite: Educational Psychology 211 or 236; consent of instructor. STAFF.

317. **Psycho-Social Educational Aspects of Deafness.** Historical and current societal preceptions of the deaf; analysis of the various effects and patterns of auditory impairment on children and adults; intelligence, personal and social adjustment, the psychological processes, and how they affect the acquisition of language, speech, speechreading, reading, and writing. ½ to 1 unit. Prerequisite: Special Education 117 and Psychology 100 or Educational Psychology 211. QUIGLEY.

318. **Workshop and Laboratory in Education of Exceptional Children.** For those specializing in exceptional children. The following sections may be offered: (a) mental retardation, (b) learning disabilities, (c) gifted children, (d) deaf children, (e) emotionally disturbed children, (f) programmed learning for exceptional children, (g) culturally disadvantaged. 1 to 2 units. Prerequisite: Consent of instructor. STAFF.

319. **Special Education of the Deaf, I.** Survey of the curriculum and techniques in preschools, kindergarten, primary, and intermediate levels as applied to the hard-of-hearing, deafened, and deaf child; study of sense training, lip reading, vocabulary development, reading techniques, elementary school subjects, language and speech development, auditory training, and curriculum construction. 1 to 1½ units. Prerequisite: Consent of instructor. STAFF.

320. **Special Education of the Deaf, II.** Continuation of Special Education 319. 1 to 2 units. Prerequisite: Special Education 319. STAFF.

321. **Education of Disturbed and Conduct-Problem Children.** A study of the social, emotional, and learning characteristics of children who are disturbed or who exhibit problems of conduct; methods of diagnosis and differentiation; educational environments and teaching methods used for their remediation. ½ to 1 unit. Prerequisite: Special Education 117 or equivalent; Educational Psychology 236 or equivalent. STAFF.

322. **Psychology and Education of the Mentally Handicapped, I.** A study of the social, emotional, physical, and learning characteristics and problems of mentally handicapped children; identification and diagnosis; available services and provisions; educational programs and curriculum of the school. ½ unit. Prerequisite: Consent of instructor. CLARK, JORDAN.

323. **Psychology and Education of the Mentally Handicapped, II.** Techniques, methods, and materials for teaching mentally handicapped children; principles underlying course of study, parent counseling, and use of records. ½ unit. Prerequisite: Senior standing in special education; consent of instructor. CLARK, JORDAN.

324. **Mental and Educational Measurement of Exceptional Children.** Designed primarily to develop an understanding of and ability to interpret the results of psychological and educational tests. Practice is provided in test administration, with emphasis on diagnosis and problems encountered in testing children who are acoustically, orthopedically, visually, or mentally handicapped, or speech defective. ½ or 1 unit. Prerequisite: Special Education 117 or consent of instructor. STAFF.

Vocational and Technical Education

COURSES FOR GRADUATES

442. **Junior College.** The place of the junior college in the modern program of public education; social, economic, and other changes responsible for development of post-secondary education as found in junior colleges, area vocational schools, and technical institutes. 1 unit. STAFF.

445. **Investment in Human Resources.** Same as Labor and Industrial Relations 445. Activities which influence future monetary and psychic income by improving the resources in people. The investments covered include schooling, on-the-job training, medical care, migration, and the search for information on prices and incomes, with main emphasis on education. A last section covers educational planning. 1 unit. Prerequisite: An introductory course in economics and in quantitative methods. STAFF.

449. **Independent Study.** To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by consent of the dean. STAFF.

450. **Evaluation in Home Economics Education.** Theory and techniques of evaluation in home economics at different educational levels; analysis and refinement of instruments, interpretation of results for self-evaluation and guidance, and effective administration of programs. 1 unit. MATHER, E. SIMPSON, SPITZE.

451. **Supervision in Home Economics Education.** The theory, principles, and techniques of pre-service and in-service training of teachers of home economics; organization, administration, evaluation, and possible future improvement of existing programs. Class visitation and other techniques practiced; supervisory materials prepared. 1 unit. MATHER.

453. **Problems in Home Economics Education.** Designed to prepare "consumers of research" through a comprehensive study and evaluation of home economics investigations now available and through the experience of carrying out an individual investigation of limited scope. 1 unit. E. SIMPSON.

456. **Problems and Trends in Specialized Fields of Vocational and Technical Education.** This course introduces the student to significant problems, points of view, and trends in the field concerned. Significant research relating to organization, content, and techniques in the field in question is explored. Students are encouraged to make special studies in approved areas. Sections are usually offered in the following fields: (a) agricultural education, (b) business education, (c) home economics education, (d) industrial education. 1 unit. STAFF.

459. **Workshop in Curriculum Development.** Curriculum development projects in the specialized fields of agriculture, business, home economics, and industry. ½ to 2 units. STAFF.

471. Policy and Program Development for Education in Agriculture. Local, state, and national policies for agricultural education; organizing for policy-making; developing desirable policies and programs. ½ unit. Prerequisite: Vocational and Technical Education 276 and 277. Open to school administrators and extension educators without prerequisite. HEMP, PHIPPS.

472. Course Planning and Teaching Procedures in Agricultural Occupations Programs. Gathering data essential in course planning, constructing course plans, developing resource units, teaching procedures, and instructional aids. ½ unit. Prerequisite: Vocational and Technical Education 276 and 277, or consent of instructor. HEMP, WALKER.

473. Vocational Education in Agriculture for Adults. The case for adult education, needs of young and adult farmers for education, development and present status of adult education in agriculture, objectives, evaluation, using advisory committees, organizing adult classes, enrolling students, course planning, teaching procedures and aids, supervised practice, group activities, facilities. ½ unit. Prerequisite: Vocational and Technical Education 276 and 277, or consent of instructor. HEMP, PHIPPS.

474. Supervised Agriculture Experience in Agricultural Occupations Programs. Supervised agricultural experience programs as an educational strategy; importance and meaning of supervised agriculture experiences; planning, conducting, supervising, and evaluating agriculture experience programs; relation of supervised agriculture experience programs to establishment and advancement in an occupation; keeping and using records; relating class instruction to supervised agriculture experience programs. ½ unit. Prerequisite: Vocational and Technical Education 276 and 277, or consent of instructor. HEMP, PHIPPS, WARMBROD.

475. Organizing and Teaching Agriculture Mechanics. Agriculture mechanics as a phase of vocational education in agriculture: purposes, course planning for high school students, young farmers, and adults; methods of teaching and evaluating on-farm or on-job instruction; planning agriculture-mechanics shops and facilities; providing and teaching safety in agriculture mechanics. ½ unit. Prerequisite: Vocational and Technical Education 276 and 277, or consent of instructor. PHIPPS.

476. Guidance in Agricultural Education. The guidance function in young farmers' adult classes, determining and preparing for agricultural opportunities, personnel included in vocational classes, preparation of plans for teaching about agricultural occupations, tests and other aids in guidance, establishment, placement, follow-up. ½ unit. Prerequisite: Vocational and Technical Education 276 and 277, or consent of instructor. HEMP, WALKER.

481. History and Basic Concepts of Vocational Education. A course in the historical development of modern vocational education, the educational theories underlying its development, and the educational concepts upon which present programs and procedures are based. 1 unit. CAMPBELL, TOMLINSON.

482. Research Studies in Vocational and Technical Education. Study and evaluation of examples of research in this field; a consideration of the research needed to solve present problems. Each student proposes and completes a brief research project, or plans in detail a major research project to be completed later. 1 unit. BALDWIN, EVANS, PHIPPS, E. SIMPSON.

487. Seminar in Vocational, Technical, and Practical Arts Education. Overview and interpretation of social, economic, and technological trends which have relevance to the problem of developing new programs in the vocational, technical, and practical arts areas; analysis and evaluation of innovations in the field; current issues and problems. 1 unit. Prerequisite: Graduate standing in vocational and technical education. EVANS, PHIPPS, E. SIMPSON, TOMLINSON.

488. **Curriculum Problems and Trends in Industrial Education.** Selection and organization of instructional materials for industrial courses; study of basic concepts underlying course construction in industrial education. 1 unit. Prerequisite: Undergraduate work in appropriate vocational and technical education courses. SREDL, STERN.

489. **Administration and Supervision of Vocational and Technical Education.** Problems and approved practices in the administration and supervision of programs of vocational, technical, and practical arts education in secondary schools, junior colleges, and technical institutes. 1 unit. Prerequisite: Consent of instructor, M. R. KARNES, PHIPPS, TOMLINSON.

490. **Seminar for Advanced Students of Education.** Seminar in vocational and technical education open only to persons who have been admitted for doctoral study in vocational and technical education. Sections of this seminar are usually offered in the following areas: (a) industrial education, (b) agricultural education, and (c) home economics education. 1 to 2 units. STAFF.

491. **Field Study and Thesis Seminar.** Usually required of candidates for the Doctor of Education. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to Ed.D. candidates. 1 to 2 units. STAFF.

499. **Thesis Research.** Individual direction of research and thesis writing. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

349. **Special Study and Investigation in Vocational and Technical Education.** A course to offer opportunity for an individual to study, on or off campus, selected problems, trends, and new developments; or to conduct specialized technological investigations for the improvement of instructional programs in areas related to vocational and technical education. ½ to 1 unit. Prerequisite: Consent of instructor; demonstrated ability to pursue special study or investigation proposed. STAFF.

370. **Agricultural Education for First-Year Teachers.** Specific help with the problems of beginning teachers. Campus meeting in August. Other meetings in centers in the state convenient to first-year teachers. Visits by instructors to schools in which first-year teachers are employed. ½ unit. Prerequisite: Vocational and Technical Education 276 and 277. WALKER.

381. **Principles of Vocational Education.** Study of basic concepts and practices of modern vocational education. ½ or 1 unit. CAMPBELL, TOMLINSON.

382. **Cooperative Vocational and Technical Education Programs.** This course is designed to provide the specific professional background required of teachers, coordinators, and administrators who organize and conduct public school programs utilizing community resources and experiences. The course includes the background, philosophy, organization, and administration of cooperative education. ½ or 1 unit. TOMLINSON.

383. **Development, Organization, and Principles of Industrial Education.** A survey of the problems and practices of the several phases of industrial education. ½ or 1 unit. SREDL, STERN.

384. **The General Shop Program.** A laboratory and theory course in the organization and administration of the industrial arts general shop program. 1 unit.

Prerequisite: Sixteen hours in appropriate vocational and technical education courses. STERN, TINKHAM.

387. **Training Programs in Industry.** A study of the organization, instruction, supervision, and evaluation of training programs conducted within industry, and their relationships to other educational agencies. 1 unit. BALDWIN.

388. **Special Techniques of Teaching Vocational-Industrial Subjects.** A study of the application of principles of industrial education in vocational-industrial education. Methods of developing industrial skills, appropriate vocational attitudes, and related technical knowledge are stressed. Lectures, discussions, and demonstrations. 1 unit. Prerequisite: Ten hours of undergraduate credit in appropriate vocational and technical education courses. CAMPBELL, STERN, TINKHAM.

ELECTRICAL ENGINEERING

Graduate work in electrical engineering leading to the Master of Science and Doctor of Philosophy is offered to graduates of electrical engineering curricula substantially equivalent to that of the University of Illinois. Graduates of curricula in the physical sciences and mathematics may also be admitted to advanced study if they have the necessary background to profit from graduate work in electrical engineering. To be admitted, an applicant must have the equivalent of a grade-point average of 4.0 or B for the last sixty semester hours of undergraduate study. Courses for advanced undergraduates and graduates are also open for credit to qualified students majoring in other fields.

A minimum of eight units must be completed for the master's degree, including a thesis. At least four units must be at the 400 level, including a course in circuit theory and one in field theory. In addition, graduate or undergraduate credit in a modern physics course is required. Courses at the 300 level which are required in the undergraduate curriculum at Illinois can not be used as part of the eight units.

All students desiring to enter the doctoral program must take the electrical engineering qualifying examination. Students who earn the master's degree at the University of Illinois take the examination during the term they earn their eighth unit of graduate credit. Students who enter with the master's degree must take the examination during the first term here.

Eight units of course credit beyond the master's degree, or the equivalent, plus eight units of thesis research and a satisfactory thesis, are minimum requirements for the Doctor of Philosophy. In addition, the candidate must demonstrate reading proficiency in two of the following languages: French, German, Russian. He also must have completed two courses in modern physics. In his course program he must offer a major and either one or two minors. A single minor requires four units in one field outside the major field, at least one of which must be at the 400 level. If two minors are chosen, each must consist of at least two units. Advanced courses in mathematics, physics, physiology, chemistry, nuclear engineering, and other branches of engineering are recommended minors.

Further details may be found in the *Electrical Engineering Graduate Study Manual*, available from the department.

GRADUATE FACULTY

Professors: E. C. JORDAN (Head of Department), H. W. ADES, F. ADLER, G. E. ANNER, W. R. ASHBY, D. S. BABB, A. D. BAILEY, J. BARDEEN, D. A. BITZER, S. A. BOWHILL, R. M. BROWN, R. T. CHIEN, P. D. COLEMAN, J. B. CRUZ, G. A. DESCHAMPS, F. DUNN, J. D. DYSON, W. L. EMERY, E. W. ERNST, W. L. EVERITT, G. H. FETT, L. GOLDSTEIN, P. HANDLER, H. N. HAYWARD, M. S. HELM, C. D. HENDRICKS, F. E. HOHN, N. HO-

LONYAK, JR., D. F. HOLSHOUSER, B. C. KUO, Y. T. LO, W. MAYEDA, P. E. MAYES, M. S. MCVAY, W. E. MILLER (Associate Head of Department), R. MITTRA, D. E. MULLER, S. MUROGA, T. A. MURRELL, G. R. PEIRCE, D. PINES, W. J. POPPELBAUM, J. E. ROBERTSON, C. T. SAH, P. F. SCHWARZLOSE, M. D. SIRKIS, L. STARK, G. W. SWENSON, JR., J. VLACH, H. M. VON FOERSTER, N. WAX, H. D. WEBB, K. C. YEH.

Associate Professors: W. G. ALBRIGHT, R. B. ASH, M. L. BABCOCK, R. W. BURTNESS, J. H. CAHN, D. H. COOPER, M. H. CROTHERS, P. R. EGBERT, F. J. FRY, O. L. GADDY, D. F. HANG, P. W. KLOCK, P. KOKOTOVIC, P. E. MAST, G. A. METZE, J. P. NEAL, W. R. PERKINS, F. P. PREPARATA, S. R. RAY, C. F. SECHRIST, J. T. VERDEYEN.

Assistant Professors: D. P. AKITT, J. W. BEAUCHAMP, B. E. CHEERINGTON, J. M. CROWLEY, A. W. DIPERT, A. H. HADDAD, S. W. LEE, C. H. LIU, E. A. MECHTLY, H. MERKELO, R. F. PIERRET, N. NARAYANA RAO, B. G. STREETMAN, T. N. TRICK.

COURSES FOR GRADUATES

400. Seminar. Required of all graduate students. No credit.

412. Advanced Engineering Measurements. Theory and practice of precision measurements of electric, magnetic, and physical quantities; factors influencing the choice of method. Comparative accuracy and practicability of measurement methods and limitation of technique; evaluation of errors; design and development of measurement apparatus and methods. 1 unit.

414. Engineering Applications of Linear Graphs. Same as Computer Science 414. Elementary theory of linear graphs, Euler graphs; incidence, cut-set and circuit matrices and their properties; realizability of cut-set, circuit and tree matrices; applications to network analysis and synthesis; signal flow graphs; applications to switching circuits and automata; communication networks. 1 unit. Prerequisite: Electrical Engineering 416; Mathematics 315 or 318.

415. Control System Theory and Design. Synthesis of feedback control systems to meet design specifications, including sensitivity; multivariable systems; introduction to systems with random inputs; state variable techniques; nonlinear systems. 1 unit. Prerequisite: Electrical Engineering 386 or equivalent, or consent of instructor.

416. Analysis of Networks and Systems. Dynamic equations of linear lumped networks and systems; time-domain analysis and state space methods; frequency-domain analysis and transform methods; stability criteria. Applications to various problems in electrical engineering. 1 unit. Prerequisite: Credit or registration in Mathematics 346 or 348; Electrical Engineering 322.

418. Electric and Magnetic Fields. Rigorous treatment of basic laws, static fields, typical field systems, harmonic functions, conjugate functions, conformal transformation. 1 unit.

420. Electromagnetic Waves and Radiating Systems. Fundamental electromagnetic theory with applications to transmission lines, waveguides, and antennas; introduction to the solution of advanced problems in static electric and magnetic fields. 1 unit. Prerequisite: Electrical Engineering 352.

421. Advanced Electromagnetic Engineering. Reciprocity and equivalence principles; formulation of scattering and diffraction problems; approximations for large and for short wavelengths; plane cylindrical, and spherical wave problems; variational methods; Wiener-Hopf techniques; applications to antennas and waveguide problems. 1 unit. Prerequisite: Electrical Engineering 420.

423. Gaseous Electronics and Plasmas. Irreversible thermodynamics; transport theory; magnetohydrodynamics; collective behavior. 1 unit. Prerequisite: Physics 362 and Electrical Engineering 420, or equivalent.

428. Analysis of Nonlinear Systems. Same as Theoretical and Applied Mechanics 428. Singular points and stability considerations are treated. Graphical and analytical methods, including the perturbation method, variation of parameters, Galerkin's method, and the Ritz method for solving nonlinear differential equations, are considered. 1 unit. Prerequisite: Mathematics 341; consent of instructor.

429. Active Networks and Feedback Systems. Active networks are analyzed in their linear small signal models. The following network functions are analyzed: driving point and transfer function, gain functions, feedback factors, gain sensitivity functions and network stability conditions. Computer calculation methods are applied to analysis and design problems. 1 unit.

431. Theory of Guided Waves. Propagation in general cylindrical waveguides; eigenvalue problems; stationary principles; microwave circuit theorems, boundary value problems, and the determination of circuit parameters; periodically loaded waveguides with anisotropic media. 1 unit. Prerequisite: Electrical Engineering 420.

432. Compound Semiconductors (Optical Devices). This course is concerned mainly with the properties of III-V and II-VI compound semiconductors and the devices which are unique to these materials. Major emphasis is placed in this course on materials such as GaAs, Ga (AsP) , GaP, CdSe, Cd (SeS) , etc., and in luminescence, semiconductor lamps and semiconductor lasers. 1 unit. Prequisite: Graduate standing in electrical engineering with some background in modern physics, elementary quantum mechanics, and elementary semiconductor theory (or equivalent) .

434. Random Processes in Electrical Engineering. Survey of measure theoretic probability theory; analysis of second order random processes, including the spectral theory and harmonic analysis; transmission of noise through linear and nonlinear systems; the signal detection problem. 1 unit. Prerequisite: Mathematics 361.

435. Theory of Semiconductors and Semiconductor Devices. Same as Physics 435. Introductory quantum mechanics of semiconductors; energy bands; dynamics of Bloch electrons in static and high frequency electric and magnetic fields; equilibrium statistics; transport theory, diffusion, drift and thermoelectric effects; characteristics of p-n junctions, heterojunctions, and transistor devices. 1 unit. Prerequisite: Physics 381 or 383.

437. Principles of Microwave Measurements. Generation and detection of the laboratory signal; the generalized impedance concept; matrix representation of waveguide discontinuities; determination of equivalent network parameters; analysis of measurement techniques by signal flow graphs; accuracy criteria. 1 unit. Prerequisite: Electrical Engineering 355 and 356.

438. Stochastic Processes in Engineering. Same as Aeronautical and Astronautical Engineering 453. Supplementing Aeronautical and Astronautical Engineering 452 or Electrical Engineering 434 for additional engineering applications of stochastic processes. Theories of random pulses and continuous Markov processes and their applications to dynamic and control systems; parametic excitations and stability; nonlinear devices; topics related to system failures. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 452, Electrical Engineering 434, or equivalent.

439. Advanced Theory of Semiconductors and Semiconductor Devices. Continuation of Electrical Engineering and Physics 435. Selected advanced topics of current interest in the physics of semiconductors and solid state devices. 1 unit. Prerequisite: Electrical Engineering and Physics 435.

440. Advanced Power Circuit Analysis, I. Analysis of power systems by symmetrical and related components; equivalent circuits of lines, transformers, and machines; fault calculations on symmetrical and unsymmetrical power systems; the network analyzer in fault studies. 1 unit.

445. Power System Stability. Transient and steady-state stability in power systems; power flow equations; transient stability swing curves; critical clearing time; the network analyzer in stability studies; the analog computer in transient stability studies. 1 unit. Prerequisite: Electrical Engineering 440.

451. Advanced Network Synthesis. Characterization of N-ports; the scattering matrix; indefinite admittance matrix; broad band matching; N-port synthesis techniques; active network synthesis; sensitivity of networks. 1 unit. Prerequisite: Electrical Engineering 324; credit or registration in Mathematics 346 and Electrical Engineering 416.

452. Time-Varying and Nonlinear Circuits. Energy considerations; equations in normal form; frequency power relations in nonlinear networks; frequency conversion; Lyapunov's direct method; the circle stability criterion; calculus of variations and Hamilton's principle applied to the stability and matching problems. 1 unit. Prerequisite: Electrical Engineering 416; Mathematics 346.

453. Optimum Control Systems. Formulation of the optimization problem; controllability; observability; stability; Lyapunov's second method; application of variational calculus, maximum principle and principle of optimality to control problems; stochastic control; adaptive control. 1 unit. Prerequisite: Electrical Engineering 415.

454. Sampled-Data Control Systems. Analysis and design of feedback control systems with digital and sampled data. 1 unit. Prerequisite: Electrical Engineering 386 or 415, or equivalent.

456. Coding Theory. Same as Computer Science 456. General discussion on coding theory with emphasis on the algebraic theory of cyclic codes; error-control procedures and circuits; applications to computers and data-transmission systems. 1 unit. Prerequisite: Mathematics 317 or equivalent, or consent of instructor.

463. Information Theory. Same as Computer Science and Mathematics 463. Mathematical models for information channels and sources; existence theorems for and construction of error-correcting codes. 1 unit. Prerequisite: Mathematics 361 or equivalent.

465. Topics in Automata Theory. Same as Computer Science and Mathematics 465. Topics selected from mathematical systems and automata theory, decision problems, formal languages, decomposition theory, etc. 1 unit. Prerequisite: Computer Science, Electrical Engineering, or Mathematics 392, or consent of instructor.

467. Atomic Collision Processes. Same as Physics 467. Elastic collisions of electrons with neutral atoms; inelastic electron-atom and electron-molecule collisions; collisions between heavy particles; molecule formation; photoprocesses and recombination; negative ions; collisions involving the emission of radiation; theory of spectral line-broadening in plasmas; experimental techniques. 1 unit. Prerequisite: Physics 481; consent of instructor.

472. Quantum Electronics. A brief theoretical introduction to quantum mechanics and atomic physics, with many applications in spin resonance and modern

maser theory. 1 unit. Prerequisite: Physics 381. It is recommended that Physics 362 and 385 be taken before registering in this course.

474. **Problems of Cybernetics.** Same as Biophysics and Communications 436. The study of brain-like processes in complex dynamic systems with emphasis on unsolved problems, current developments, and opportunities for research. 1 unit. Prerequisite: Consent of instructor.

475. **Ionospheric Radio Propagation.** Propagation in a stratified medium; WKB solution; ray theory; ionospheric sounding; ionospheric transmission problems; scattering by irregularities; propagation in a random medium; cross-modulation and nonlinear effects; magneto-ionic theory; Faraday effect; whistler propagation; coupling of characteristic waves; magneto-hydrodynamic waves; formation of ionospheric E-region; formation of F-region. 1 unit. Prerequisite: Electrical Engineering 420 or equivalent.

481. **Threshold Logic.** Same as Computer Science 481. Mathematical model of computer elements which work under threshold or majority principle; mathematical theory of threshold functions; realizability using a linear programming approach; network syntheses of majority principle devices. 1 unit. Prerequisite: Consent of instructor.

482. **Theory of Digital Computer Arithmetic.** Same as Computer Science 482. This course emphasizes the use of redundancy in the representation of digits in order to increase the efficiency of computer arithmetic. Topics include multiplier recoding, division with redundantly represented quotients, and structural redundancy as implied by carry-save and signed-digit techniques. 1 unit. Prerequisite: Computer Science or Electrical Engineering 394.

485. **Advanced Theory of Magnetic and Optic Computer Memory Devices.** Same as Computer Science 485. Theory of ferromagnetism and superconductivity applied to memory devices; light propagation in anisotropic media: modulators and deflectors; principles of laser operation. 1 unit. Prerequisite: Electrical Engineering or Computer Science 385.

486. **Constitution of the Ionosphere: An Introduction to Aeronomy.** Same as Astronomy 486. Properties of the neutral and ionized atmosphere above 60 km. height, and the photochemical processes causing them; diffusion of ionospheric constituents; solar and meteoric perturbations of the ions of the ionosphere. 1 unit. Prerequisite: Graduate standing in electrical engineering, physics, or astronomy; Mathematics 341 or equivalent.

490. **Seminar in Special Topics.** Lectures and discussions on current research and literature on advanced topics in electrical engineering. Course may be repeated. 0 to ½ unit. Prerequisite: Advanced standing; consent of instructor.

497. **Electrical Engineering Problems.** Lectures and discussions relating to new areas of interest. 0 to 1 unit. Course may be repeated. Prerequisite: Consent of instructor.

498. **Individual Study.** Individual projects. ½ to 2 units. Prerequisite: Consent of instructor.

499. **Thesis Research.** 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

322. **Linear Network Theory, II.** Signal representation in terms of Fourier series, Fourier transforms, and Laplace transforms; role of exponential and sinusoidal signals in system analysis for arbitrary waveforms; two-ports and filters as signal processors. 0 to 1 unit. Prerequisite: Electrical Engineering 250 and 251; Computer Science 101; Mathematics 345.

323. **Circuit Laboratory.** To accompany Electrical Engineering 322 and 350. 0 or ¼ unit. Prerequisite: Electrical Engineering 251 and 262; credit or registration in Electrical Engineering 350.

324. **Introduction to Network Synthesis.** An introduction to modern methods of network synthesis; properties of driving-point and transfer functions; approximation and scaling; LC, RC, and RLC synthesis methods; ladder network development; and resistively terminated coupling networks. 0 to 1 unit. Prerequisite: Electrical Engineering 322.

330. **Magnetic Circuits and Transformers.** Magnetic circuit analysis; transformer theory; special magnetic circuit applications. 0 to ¾ unit. Prerequisite: Electrical Engineering 229, 250, and 251; credit or registration in Electrical Engineering 331.

331. **Magnetic Circuits and Transformers Laboratory.** To accompany Electrical Engineering 330. 0 or ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 330.

332. **Electrical Machinery.** Induction machines; single-phase motors; direct-current machines; application. 0 to ¾ unit. Prerequisite: Electrical Engineering 330 and 331; credit or registration in Electrical Engineering 333.

333. **Electrical Machinery Laboratory.** To accompany Electrical Engineering 332. 0 or ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 332.

336. **Advanced Analysis of Electric Power Equipment.** Transformers, synchronous and induction machines; power machines in systems; single phase motors; extension of the two-reaction analysis to the general machine. 0 or 1 unit. Prerequisite: Electrical Engineering 330 and 331.

340. **Electronics, I.** Semiconductor materials and their electronic properties and applications to electronic devices; p-n junctions, transistors, and other diode and triode devices; low-frequency applications of diodes. 0 to ¾ unit. Prerequisite: Electrical Engineering 260; Physics 108.

341. **Electronics Experimentation.** Problems of experimentation and measurement with electronic circuits and devices. Lecture and laboratory. 0 or ¼ unit. Prerequisite: Electrical Engineering 251; credit or registration in Electrical Engineering 340.

342. **Advanced Electronics.** Linear and nonlinear amplification; modulation and demodulation concepts; introduction to feedback amplifiers and oscillators. 0 to ¾ unit. Prerequisite: Electrical Engineering 262, 340, and 341.

343. **Electronics Laboratory.** 0 or ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 342.

344. **Theory and Fabrication of Solid State Devices.** A laboratory and lecture course on the physical theory, design, and fabrication of solid state devices which includes the electronic properties of semiconductors (such as mobility, carrier concentration, lifetime, energy gap) and techniques for fabricating (oxidation, diffusion, oxide masking, alloying) p-n junction devices. 1 unit. Prerequisite: Electrical Engineering 340.

347. **Industrial Electronics.** Electronic circuits for automatic control and measurement systems with applications. 0 to 1 unit. Prerequisite: Electrical Engineering 322, 330, and 342. Credit toward graduation is not given for both Electrical Engineering 347 and 381.

349. **Nonlinear Electronic Circuits.** An introduction to the elementary solution of zero, first-, and second-order differentio-integral equations encountered in the study of electronic circuits. Circuits used as examples employ uni- and bipolar

transistors, unijunctions, tubes, and other devices. Emphasis is given to nonlinear negative resistance applications in switching applications and in oscillators of the relaxation and quasi-sinuoidal types. ¾ or 1 unit. Prerequisite: Electrical Engineering 340.

350. Lines, Fields, and Waves. Transmission lines, field calculations, and wave propagation. ¾ unit. Prerequisite: Electrical Engineering 229; Computer Science 101; credit or registration in Electrical Engineering 323.

352. Electromagnetic Fields. Uniform plane waves, wave guides, radiation and propagation of electromagnetic energy, radiating systems, and electrodynamics. ¾ unit. Prerequisite: Electrical Engineering 350 and 323; concurrent registration in Electrical Engineering 356 is recommended.

353. Radio Circuits. Component behavior at communication frequencies, impedance transforming networks for single and multiple frequencies; low-level tuned and compensated amplifiers, broad band impedance matching; equalizers. 0 to 1 unit. Prerequisite: Electrical Engineering 322.

355. Fields and Waves. Electromagnetic fields; wave guides; radiation and propagation of electromagnetic energy; radiating systems. 0 or ¾ unit. Prerequisite: Electrical Engineering 229 and 350, or consent of instructor.

356. Microwave Techniques. UHF and microwave sources and detectors; laboratory techniques for UHF and microwave frequencies. 0 or ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 352 or 355.

357. Radio Astronomy. Same as Astronomy 357. Instrumental theory and observational techniques; radar and meteors; the moon and planets; solar radio waves; galactic and extragalactic radio astronomy. 1 unit. Prerequisite: Physics 108.

359. Introduction to Noise and Information Transmission. Signals and their spectra; methods of communication systems analysis; modulation by AM, FM, PAM, PPM; origin of noise, properties of noise, introduction to probability theory, system comparison using statistical approach. ¾ or 1 unit. Prerequisite: Electrical Engineering 322; credit or registration in Electrical Engineering 342.

366. Aeronomy: Physics of Upper Atmosphere and Space. Same as Astronomy and Physics 366. Structure and composition of the Earth's upper atmosphere, solar radiation and its interaction with the upper atmosphere; the ionospheric layers; planetary atmospheres; airglow and aurora; interplanetary plasma; the magnetic field of the Earth and its interaction with the solar plasma; experimental techniques. 1 unit. Prerequisite: Physics 342, 321 and 381, or consent of instructor.

367. Active Networks. A study of active device models and their application to electrical network equation forms. Systems are expressed in terms of their network functions; the characteristics of feedback systems are examined in particular. Sensitivity and stability factors are examined. ¾ unit. Prerequisite: Electrical Engineering 342.

373. Engineering Acoustics. Same as Theoretical and Applied Mechanics 373. Development of the basic concepts needed for the understanding of mechanical and electrical acoustic systems: vibrating string; vibrating membrane; plane waves; spherical waves; vibrating piston; accoustical filters; loudspeakers and microphones; principle of reciprocity; the ear; architectural acoustics. ¾ or 1 unit. Prerequisite: Mathematics 345 or equivalent, or consent of instructor.

376. Symmetrical Component Analysis of Power Systems. Representation of power systems; symmetrical components, positive, negative and zero sequence impedances of network components, sequence networks; unsymmetrical faults, unsym-

metrical power systems, matrix algebra in symmetrical component analysis. 0 or 1 unit. Prerequisite: Electrical Engineering 350.

378. **Electric Power Networks.** Steady-state power network analysis; inductive coordination; transmission line capacitance and resistance; networks synthesis; application of computers to power network problems. 0 or 1 unit. Prerequisite: Electrical Engineering 350; credit or registration in Electrical Engineering 332.

381. **Pulse Techniques.** An introduction to the response of electrical networks to non-sinusoidal inputs, the analysis of active circuits with large signals, and the circuits and techniques used in pulse and digital equipment. Credit toward graduation is not given for both Electrical Engineering 381 and 347. 0 or 1 unit. Prerequisite: Electrical Engineering 322 and 341, or consent of instructor.

382. **Transistor Circuits.** This course is the same as Electrical Engineering 383 but has one three-hour laboratory added each week. 1 unit. Prerequisite: Electrical Engineering 340, 342, and 343, credit or registration in Electrical Engineering or Metallurgical Engineering 384, or consent of instructor.

383. **Transistor Circuits.** Junction transistors, diodes, and related semiconductor devices. Emphasis equally divided between device properties as related to semiconductor physics and circuit properties. Small signal theory of amplifiers and oscillators, large signal theory of power stages and switching circuits, negative resistance effects, high frequency limitations. ¾ unit. Prerequisite: Electrical Engineering 342, credit or registration in Electrical Engineering or Metallurgical Engineering 384, or consent of instructor.

384. **Properties of Solids.** Same as Metallurgical Engineering 384. Perfect and imperfect crystal lattices, electronic structure of solids, including basic theory, and applications to transport properties of metals and semiconductors, semiconductor diodes, dielectric and magnetic properties of solids. ¾ unit. Prerequisite: Physics 383.

385. **Theory of Semiconductor Computer Devices.** Same as Computer Science 385. Crystal conduction; large signal d-c and transient behavior of semiconductor devices; charge storage theory, phase plane diagrams, tolerance optimization, and noise theory; integrated circuits technology; masking, oxidizing, and etching; emphasis on device-theoretical background for computer logic design. ¾ or 1 unit. Prerequisite: Computer Science or Electrical Engineering 294, or consent of instructor.

386. **Fundamentals of Servomechanisms.** Fundamental knowledge required in the analysis of servomechanisms and automatic control devices. 0 or 1 unit. Prerequisite: Consent of instructor.

387. **Introduction to Quantum Electronics for Electrical Engineers.** Application of quantum mechanical concepts to electronics problems; for example: the generation and detection of coherent radiation, tunneling effects, and bulk oscillations in semiconductors. 1 unit. Prerequisite: Physics 383.

388. **Electronic Analog Computers.** Design of analog computer elements, problem preparation, and representative solutions of physical problems. 0 or 1 unit. Prerequisite: Electrical Engineering 340, 341, and Mathematics 345, or consent of instructor.

389. **Communication Design.** Over-all communication design problems; kinds of propagation; noise and interference; antenna temperature; transmitter power requirements; frequency selection; design of a portion of a receiver, transmitter, or antenna. 0 or ¾ unit. Prerequisite: Electrical Engineering 342 and 350.

391. **Boolean Algebra and Switching Theory.** Same as Computer Science and Mathematics 391. Boolean algebra with applications to sets, logic, electronic

and relay combinational circuits; Karnaugh and Quine-McCluskey minimization procedures with applications; introduction to sequential circuits. ½ or 1 unit. Prerequisite: Consent of instructor.

392. Introduction to Automata Theory. Same as Computer Science and Mathematics 392. Semigroups, partially ordered sets, and other algebraic systems; asynchronous machines; abstract synchronous machines and their properties; regular sets; decomposition theory. ½ or 1 unit. Prerequisite: Computer Science, Electrical Engineering, or Mathematics 391, or consent of instructor.

393. Digital Computer Circuit Design. Same as Computer Science 393. Design of switching circuits and systems taking into account properties of currently available diodes, transistors, and related circuit elements; applications to slow-speed as well as high-speed computer circuits and data handling links; component tolerance, circuit reliability, and cost factors are considered. 1 unit. Prerequisite: Computer Science or Electrical Engineering 294 or 391; Electrical Engineering 342; or consent of instructor.

394. Logical Design of Automatic Digital Computer Circuits. Same as Computer Science 394. A course in the design of automatic digital computers. Major emphasis is on logical structure of components and the interrelations necessary for automatic operation. 1 unit. Prerequisite: Computer Science or Electrical Engineering 294, or consent of instructor.

ENGLISH LANGUAGE AND LITERATURE

(Including American Literature and Rhetoric and Composition)

Students who wish to be considered for admission to graduate work in English must have attained a grade-point average of at least 4.0. All students must present the equivalent of at least twenty hours of undergraduate work in English or American literature, although students with at least fourteen hours may be considered on an individual basis and granted probational entrance. This does not include required college work in rhetoric or composition.

Master of Arts in English. In addition to satisfying the general requirements of the Graduate College, candidates must complete two courses in each of three areas of study as recognized by the department and must demonstrate proficiency in one language chosen from French, German, Latin, and Italian. Other languages may be substituted with permission of the Director of Graduate Studies where the substituted language has particular relevance to the student's professional interests.

A master's thesis is not required, but each candidate must deposit one term paper with the department.

Master of Arts in the Teaching of English. Candidates must earn at least four units in English, at least two of them in courses at the 400 level, and they must take the final examination for master's candidates in English. They must also deposit one term paper with the department. Candidates must also have had the equivalent of at least two years of undergraduate work in French, German, Latin, Greek, Russian, or Spanish.

Specific requirements are divided into two programs, the first for those who have the Bachelor of Arts in English and the teacher's certificate, and the second for those who have the Bachelor of Arts in English but not the teacher's certificate. See pages 38 and 39.

For those with the certificate, the requirements are English, four units, including at least one course above the 450 level; education, two units as follows: one unit in Educational Psychology 311 and 312, and one unit chosen from History and Philosophy of Education 301, 302, 303, 304, or 305; specialized courses for high

school teachers of English, as follows: one unit of either Secondary and Continuing Education 456 or English 447; three-quarters unit of either English 387 or 370; electives as needed to total at least eight units.

For those without the certificate, the requirements are English, four units, including at least one course above the 450 level; education, two units as follows: one-half unit in Educational Psychology 311, one-half unit in Educational Psychology 312, and one unit chosen from History and Philosophy of Education 301, 302, 303, 304, or 305; specialized courses for high school teachers of English, three-quarters unit in either English 387 or 370; electives, as needed to total eight units. In addition to these courses, the candidates must take, without graduate credit, Secondary and Continuing Education 241 and Educational Practice 242. This program is designed to permit candidates to complete their work and qualify for a certificate and master's degree in two semesters and a summer. Those who lack certain prerequisites, such as general psychology, may need a little more time.

Electives may be in English, in education, or in exceptional cases, in other subjects.

Master of Arts in the Teaching of English as a Second Language. The Master of Arts in the Teaching of English as a Second Language incorporates courses from two core areas: English and linguistics. The curriculum has two options. Students who later seek a Ph.D. in one of the core areas may apply some courses from this curriculum toward a doctorate with approval of the department of their specialization.

Applicants for admission must satisfy general requirements of the Graduate College and must present appropriate academic preparation in one of the core areas, in secondary education in the teaching of English, or in elementary education. Applicants with majors in related areas, such as a foreign language, speech, or one of the social studies, are considered on an individual basis. Native speakers of English must have achieved proficiency in one foreign language that is equivalent to at least two years of undergraduate study. Non-native speakers of English must demonstrate acceptable proficiency in English.

Option 1. Candidates for the degree must earn a total of eight units, at least five of which are in the core areas and two in education. Candidates must pass the final comprehensive examination in the core areas and must deposit with the department one term paper or an essay on a topic related to the teaching and learning of English as a second language.

Option 2. The general requirements for the completion of the degree in Option 1 apply also to Option 2. However, the curriculum for Option 2, which may require eight to ten units, depending upon the student's preparation, includes a one-year internship teaching English in Puerto Rico. This internship is integrated with academic study under the direction of the University of Illinois faculty in the field and on campus. The candidate receives two units of credit based on his internship (one unit in English or Linguistics and one unit in the History and Philosophy of Education). One of the papers submitted for credit on the internship is to be deposited with the department.

Doctor of Philosophy in English. In addition to satisfying the general requirements of the Graduate College, candidates must take at least two units of work in problems courses—those courses numbered 450 and higher. The department recommends that all work be taken at the 400 level.

Proficiency Examination. Graduate students entering the doctoral program are required to take a proficiency examination early in their first semester—or summer session—of residence.

Foreign Languages. Each student must demonstrate proficiency in two languages chosen from French, German, Latin, and Italian. Other languages may be substituted with permission of the Director of Graduate Studies where the substituted language has particular relevance to the student's professional interests.

Minor Subjects. Students may offer a double minor, which includes English philology and one other subject, or a sole minor in English philology.

Preliminary Examination. This examination is given in October, January, and April of each year. It consists of two parts, a written examination and an oral examination.

Thesis. The student must submit a statement of his thesis plan, outlining its main topics, to the adviser within a reasonable period after he passes his preliminary examination.

More detailed information may be obtained by requesting a mimeographed statement, "Graduate Studies in English," from the Director of Graduate Studies, Department of English, 100 English Building.

GRADUATE FACULTY

Professors: A. L. Altenbernd (Head of Department), A. E. Barker, L. E. Berry, J. J. Campbell, E. H. Davidson, J. T. Flanagan, R. H. Green, G. Hendrick, A. G. Holaday, J. N. Hook, B. A. Milligan, R. W. Rogers, C. H. Shattuck, D. A. Smalley, J. Stillinger, H. W. Wilson.

Associate Professors: Katharine O. Aston, E. J. Brandabur, W. M. Curtin, J. A. Dussinger, R. L. Fumento, F. E. Hodgins, U. M. Kaufmann, D. V. Kramer, R. J. Loftus, S. Millet, F. B. Moake, A. C. Purves, C. Sanders, R. L. Schneider, A. L. Scott, G. Scouffas, J. K. Simon, G. B. Stillwell, R. H. Wasson, B. F. Wilkie.

Assistant Professors: R. R. Allen, Nina Baym, H. C. Cole, J. R. Hurt, K. Kinnamon, D. Majdiak, R. D. Rhodes, J. F. Stottlar, J. C. Stubbs, A. Tibbetts, J. B. Trahern, D. E. Whisnant, G. G. Wright.

English Literature and American Literature

COURSES FOR GRADUATES

401. Old English: Anglo-Saxon. An introduction to the language before 1000 A.D. 1 unit.

402. Old English: Beowulf. 1 unit. Prerequisite: English 401.

403. History of the English Language. A study of the development of the language from the earliest stages to the present time. 1 unit.

404. Old English Literature and Its Cultural Background. An intensive, critical examination of Old English prose and poetry exclusive of Beowulf. The texts studied vary from year to year, but particular attention is given to such important bodies of writing as the Elegies, the *Anglo-Saxon Chronicle,* and the works of Cynewulf, Aelfric, Alfred, and Wulfstan. 1 unit. Prerequisite: English 401 and 402.

405. Middle English. Introduction to Middle English dialects, with special emphasis on the East Midland. 1 unit. Offered in 1970-1971 and in alternate years.

406. Middle English Literature and Its Cultural Background. English literature from 1100 to 1500 (excluding Chaucer), with emphasis on chronicle, romance, debate, lyric, and such major poems as *Pearl, Sir Gawain and the Green Knight,* and *Piers Plowman;* historical, social, and religious backgrounds. 1 unit.

407. Studies in Chaucer and His Times, I. A study of Chaucer and his contemporaries. The chief aim of this course is an intimate acquaintance with Chaucer's poetry and an appreciation of his art. 1 unit.

408. Studies in Chaucer and His Times, II. Continuation of English 407. 1 unit.

411. Studies in Sixteenth-Century Literature, I. 1 unit.

412. Studies in Sixteenth-Century Literature, II. Continuation of English 411. 1 unit.

413. Studies in Shakespeare. 1 unit.

414. Studies in Elizabethan Drama. 1 unit.

416. Studies in Late Renaissance Thought and Literary Theory. The development of cultural ideas—religious, social, educational—in representative prose writers of the late sixteenth century and of the seventeenth century (Hooker, Bacon, Burton, Browne, Milton, Dryden, and others) in relation to literary theory and practice. 1 unit.

417. Studies in Seventeenth-Century Poetry and Milton (1600–1640). 1 unit.

418. Studies in Seventeenth-Century Poetry and Milton (1640-1700). Continuation of English 417. 1 unit. Prerequisite: English 417.

421. Studies in Eighteenth-Century Literature, I. 1 unit.

422. Studies in Eighteenth-Century Literature, II. Continuation of English 421. 1 unit.

423. Studies in the Eighteenth-Century Novel. 1 unit.

427. Studies in the Romantic Movement, I. 1 unit.

428. Studies in the Romantic Movement, II. Continuation of English 427. 1 unit.

431. Studies in Victorian Literature, I. 1 unit.

432. Studies in Victorian Literature, II. Continuation of English 431. 1 unit.

433. Major Movements in Modern British Poetry and Drama. A study of important movements, figures, and ideas which shaped the criticism and practice of modern poetry. 1 unit.

434. Major Movements in Modern British Fiction. A study of important movements, figures, works, and ideas which shaped the criticism and practice of modern fiction. 1 unit.

437. Studies in American Literature: 1600 to 1800. Studies in the Puritan mind from Bradford through Jonathan Edwards and in the Enlightenment, with Franklin, Jefferson, Paine, and the first literary artists as the bases of inquiry. 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: A survey course in American literature or consent of instructor.

438. Studies in American Literature After 1800. A course which investigates literary movements, major writers, and intellectual and cultural ideas in American literature from 1800 to the present. The subject matter of the course varies each time it is offered. 1 unit. Prerequisite: Survey course in American literature or consent of instructor.

442. Studies in Recent Literary Theory. The analysis of representative critics and critical schools of the twentieth century; similarities and differences between them and older critics in the solutions proposed to the central problems of literary theory. 1 unit.

445. Introduction to Advanced Graduate Study. A consideration of the methods and aims of literary scholarship. 1 unit.

446. Introduction to Advanced Graduate Study. A consideration of the methods and aims of literary criticism, and of the profession of college English teaching. 1 unit.

447. Background Materials for High School Teachers of English. Investigation of the content that is desirable in high school literature and composition. S; 1 unit.

448. Literary Analysis for Teachers of English. An examination of the theoretical considerations underlying various approaches to teaching literature at the high school and introductory college level. 1 unit. Prerequisite: Teaching experience at secondary or college levels.

450. Problems in Bibliographical Method. Same as Library Science 440. Work on individual bibliographical problems, with a study of bookmaking, manuscripts and their relation to the printed text, editorial problems, and literary forgeries. 1 unit. Prerequisite: Consent of instructor.

457. Problems in Medieval Literature. A conference and research course devoted to special problems, literary movements, and writers of the period. 1 unit.

458. Problems in Sixteenth-Century Literature. A conference and research course devoted to special problems, literary movements, and writers of the period. The subject matter of the course varies each time it is offered. 1 unit. Prerequisite: English 411, 412, or equivalent; or consent of instructor.

462. Problems in Tudor Drama. 1 unit.

463. Problems in Shakespeare. 1 unit.

464. Problems in Elizabethan Drama. 1 unit.

466. Problems in Seventeenth-Century Metaphysical Poetry and Prose. Literary technique in relation to intellectual and religious problems in the poetry and prose of John Donne, his contemporaries and successors. 1 unit. Prerequisite: English 345 or 417, or consent of instructor.

467. Problems in Milton and His Age. 1 unit. Prerequisite: English 342 or 418 or consent of instructor.

469. The Stage History of Classic English Plays. Same as Speech 469 and Theatre 469. Analysis and reconstruction of past productions of classic plays, with special reference to Shakespeare. 1 unit. Prerequisite: One year of work in dramatic literature or theatre history; consent of instructor.

471. Problems in Eighteenth-Century Literature. A conference and research course devoted to special problems, literary movements, and writers of the period. The subject matter of the course varies each time it is offered. 1 unit.

476. Problems in Romantic Literature. A conference and research course concerning special problems, literary movements, and writers of the English Romantic period. The subject matter of the course varies each time it is offered. 1 unit.

478. Problems in Prose Fiction. 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Second-year graduate standing.

479. Problems in Victorian Literature. Prerequisite: English 431 or 432 or consent of instructor. 1 unit.

480. The English Novel in Transition, 1890-1914. An examination of the works of principal Edwardian novelists, chiefly John Galsworthy, Arnold Bennett, and H. G. Wells, in terms of the transition of the English novel from Victorian to modern. 1 unit.

484. Problems in Twentieth-Century English Literature. A conference and research course devoted to selected writers and critical movements of the period. 1 unit. Prerequisite: English 433 or consent of instructor.

486. Problems in American Criticism and American Culture. Papers and discussions on literary critics and historians who have used literature as an index to the problems of American culture, 1900-1959. 1 unit. Prerequisite: English 376.

488. Problems in American Literature and Cultural History. 1 unit. This course may be repeated for a total of two units. Prerequisite: A survey of American literature or consent of instructor.

491. Research in Special Topics. Research in selected topics by arrangement with the instructor. This course may be repeated for a total of two units. 1 unit.

497. Independent Reading. A course in individual readings from the areas of literature as offered by the department at the advanced undergraduate-graduate level. May only be taken concurrently with a 300-level course. No student may offer more than a total of ½ unit of English 497. Prerequisite: Consent of instructor of requisite 300-level course. ¼ unit.

499. Thesis Research. Guidance in writing theses for advanced degrees. 0 to 4 units. ALTENBERND, BARKER, BERRY, BRANDABUR, CAMPBELL, DAVIDSON, FLANAGAN, R. GREEN, HOLADAY, HOOK, KAUFMANN, KRAMER, LOFTUS, MARDER, MILLET, MILLIGAN, PURVES, ROGERS, SCOTT, SHATTUCK, SIMON, SMALLEY, STILLINGER, WILKIE, WILSON.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. Historical Introduction to the English Language. Relation of English to other languages; major phonological, morphological, syntactic, and lexical changes in English from the beginnings to the present. ¾ unit. Prerequisite: English 386.

310. Literature for the High School. An introduction to the guidance of high school readings in literature, including a survey of books of graduated difficulty through an individualized program of independent reading, an examination of reference tools and teaching materials in English, but with chief emphasis upon an intensive critical study of representative works. ¾ unit.

311. Chaucer. ¾ unit.

316. American Drama from 1900 to 1960. A survey of American dramatic literature of the twentieth century, including the reading of a large number of plays which illustrate the diversity and importance of modern American drama. Special attention is given to the work of Maxwell Anderson and Eugene O'Neill. ¾ unit.

325. English Literature from 1500 to 1660. Survey of English literature of the Renaissance, exclusive of Milton and the drama. ¾ unit.

326. Spenser and His Contemporaries. A study of the principal preoccupations and forms of Elizabethan poetry, with special reference to Spenser. ¾ unit. Prerequisite: Six hours of English literature.

336. English Drama Exclusive of Shakespeare. From 1600 to 1700. ¾ unit.

338. Tragedy. Comparative study of masterpieces in several periods of Western culture. Major emphasis on ancient Greek and Roman, and English Elizabethan and Stuart drama. ¾ unit.

339. Comedy. The history and theory of comic drama. ¾ unit.

340. Satire. Comparative study of the chief nondramatic satires of Western civilization, from Roman times to the present. Particular emphasis is given to the bearing these works and traditions have on English satire. ¾ unit. Offered in 1970-1971 and in alternate years.

342. The Poetry of Milton. Origins, forms, artistic and ethical values; Milton's place in English literary history. ¾ unit.

345. The Metaphysical Poets. Class reading and discussion of the poetry of the principal members of the group known as the Metaphysical Poets (Donne, Herbert, Vaughn, Crashaw), with special emphasis on the poetry of John Donne. ¾ unit.

346. The Age of Dryden. A study of Restoration literature, dramatic and non-dramatic, centered around Dryden. ¾ unit.

348. Swift, Pope, and Fielding. A study of the principal ideas and methods of satire as revealed in the writing of the three major English satirists. Written reports and extensive readings. ¾ unit. Prerequisite: A course in English literature.

349. Dr. Johnson and His Circle. The principal writings of Johnson, Boswell, Goldsmith, Reynolds, Burke, Gibbon, and Sheridan; the position of Johnson's circle in the social and literary life of the second half of the eighteenth century. ¾ unit.

351. The Mid-Victorian Novel. Thackeray, Emily Brontë, Mrs. Gaskell, Dickens, George Eliot, Trollope. ¾ unit.

352. American Literature: Irving to Whitman. A study of the major American writers from 1800 to the Civil War, with particular emphasis on Cooper, Poe, Emerson, Thoreau, Hawthorne, Melville, and Whitman. ¾ unit.

354. Studies in Middle Western Literature, II. A survey of Middle Western literature from 1900 to the present, with special emphasis on the development of realism in poetry and fiction. ¾ unit. Offered in 1970-1971 and in alternate years. Prerequisite: One course in American history or one of the following: English 255 or 256.

359. The International Folk Tale. Same as Comparative Literature 359. A study of the origin, distribution, and nature of the folk tale with special reference to themes and variants. Representative tales of various areas (Africa, Germany, Greece, India, Ireland, Japan, Norway) are analyzed, and North American Negro and Indian tales are discussed. ¾ unit.

360. The Popular Ballad and the Folk Song in the United States. A study of the British and Scottish popular ballad—the Child ballad as it is familiarly known—as it developed in Great Britain and as it was transplanted to the United States, with special emphasis on the development of native American ballads and songs. ¾ unit.

363. Advanced Dramatic Writing. Same as Speech 363, Radio and Television 363, and Theatre 380. Application of principles of dramatic form and structure to the more complex problems of playwriting. Practice in writing sustained dramatic forms. ½ or 1 unit; students may accumulate 2 units of credit. Prerequisite: Speech 263 or equivalent; consent of instructor.

370. Theory and Practice of Written Composition. History and theory of written composition; basic rhetorical principles; guidance and criticism of student writing. ¾ unit.

371. History and Principles of Literary and Rhetorical Criticism: Aristotle to Sidney. Same as Speech 371. ½ or 1 unit.

372. History and Principles of Literary and Rhetorical Criticism: Sidney to the Present. Same as Speech 371. ½ or 1 unit.

375. Henry James and the Technique of Fiction. A study of the development of

Henry James as a novelist, of influences upon him, and of his influence on novelists of the twentieth century, chiefly American. ¾ unit.

376. American Criticism and American Culture. This course examines the basic problem of the relation of literature to the Republic as a continuing historical issue; the idea of a national literature, the function of the artist in a democracy, the content and range of American criticism. The analysis centers on the major American critics. ¾ unit. Prerequisite: English 255 and 256.

377. Major American Poets. A study of Poe, Whitman, Dickinson, Frost, Eliot, and Cummings with emphasis upon critical interpretation of their writings and the kinds of literary form characteristic of them. ¾ unit. Prerequisite: A course in English or American literature.

378. Modern American and British Fiction in Its European Background. A study of the interrelationship between certain themes and techniques in the development of the contemporary American, British, and European novel (from Dostoevsky, Melville, and Conrad through Mauriac, Dos Passos, Kafka, Gide, Faulkner, and Sartre to the present day). ¾ unit. Prerequisite: Two college-level literature courses.

380. Mark Twain and the Rise of Realism. A study, with special emphasis upon Mark Twain, of the rise of realism in American fiction from 1850 to 1900. ¾ unit. Prerequisite: English 256 or consent of instructor.

381. Themes and Movements in British Literature. An intensive study of a recurrent idea or of a literary situation. ¾ unit. Prerequisite: Six hours of English or American literature.

382. The Plays of Bernard Shaw. ¾ unit.

384. Comparative Studies in Twentieth-Century Poetry. A study of contemporary poetry in English in its relationship to modern European verse. The poets studied may vary each time the course is offered. ¾ unit. Prerequisite: Three hours in either poetry or modern literature, or consent of instructor.

385. Themes and Movements in American Literature. An intensive study of a recurrent idea or of a literary situation. ¾ unit.

386. Modern English Grammar and Usage. Traditional and contemporary grammars; principles of usage. ¾ unit.

387. The Structure of English. Same as Linguistics 387. Critical evaluation of traditional and structuralist grammatical descriptions; introduction to transformational grammatical studies; detailed survey of a transformational syntax of English; brief introduction to generative phonology and morphophonemic analysis of English, especially stress. ¾ unit.

392. Typographic Disciplines of the Book. Same as Journalism and Library Science 310. The study of the book as a manufactured object, with emphasis upon practices and methods in continuous use from the Renaissance to the present, including type faces, paper, binding, and illustration. Extensive practicum in the typographic laboratory. ½ unit. Prerequisite: Consent of instructor.

394. Introduction to Folklore: History, Theory, Methods. Same as Comparative Literature, German, and Slavic 394, and Speech 346. An introduction to the study of folklore with emphasis on folkcultures in the Old and New World; an historical survey of the development of folklore study, an analysis of the methods and genres of folklore, and an introduction to field collecting and evaluation of archival materials. ¾ unit. Prerequisite: A reading knowledge of one modern foreign language is recommended.

Rhetoric and Composition

COURSES FOR GRADUATES

400. Verbal Communication in English as a Second Language for Graduate Foreign Students, I. A language laboratory course concentrating on the typical writing problems that a graduate or research student encounters in an American university. No graduate credit. Prerequisite: Rhetoric 111 or consent of instructor.

401. Verbal Communication in English as a Second Language for Graduate Foreign Students, II. A language laboratory course dealing with individual, immediate, and specialized speaking and writing problems, with particular attention to orienting the graduate student to the techniques of the American university in thesis and other specialized writings and in the oral presentation of such material. No graduate credit. Prerequisite: Rhetoric 400 or consent of instructor.

419. Contrastive Linguistics. Same as Linguistics 419. A critical survey of contemporary linguistic models with special reference to their relevance in preparing contrastive analyses of languages; detailed discussion on contrastive analyses of English and selected non-western languages at different linguistic levels. ½ or 1 unit. Prerequisite: Linguistics 300 or consent of instructor.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

330. The Writing of Poetry. The practice of the writing of poetry, aided by intensive study of examples. ¾ unit. Prerequisite: Six hours of English or American literature, or consent of instructor.

388. Linguistics in Language Learning, I. Same as Linguistics 388. The application of linguistic methods in the learning of a second language, with special emphasis on the learning of English. ¾ unit. Prerequisite: Two years of a foreign language or equivalent; consent of instructor.

389. Linguistics in Language Learning, II. Same as Linguistics 389. Applied linguistics in teaching and learning English as a second language, with special emphasis on the application of some principles of psycholinguistics, sociolinguistics, and ethnolinguistics along with the related disciplines of education, psychology, and anthropology to structured teaching/learning situations. ¾ unit. Prerequisite: Rhetoric 388.

ENTOMOLOGY

See descriptions and course listings under Life Sciences, page 275.

EXTENSION EDUCATION

This program leads to the professional degree of Master of Extension Education and is open to persons holding a bachelor's degree in agriculture, home economics, or a closely related area. Admission to the program requires a grade-point average of at least 3.5 for the last sixty semester hours of undergraduate work.

Candidates are required to complete a minimum of eight units, and nine units are required if a thesis is not submitted. Three of these units must be in 400-level courses with one unit in the major field. A major (four units) may be taken in

agriculture, home economics, or the social sciences. Students majoring in agriculture or home economics select four additional units from the social sciences; those majoring in the social sciences select four additional units from agriculture or home economics. All courses selected must be approved by the student's adviser. If a thesis is not submitted, the ninth unit may be selected in any area approved by the adviser. Students majoring in home economics must take work in three of the four major divisions of the department, unless proficiency in one or more of the areas is demonstrated by examination. At least four units must be earned in residence on the Urbana campus. Total extramural credit can not exceed three units.

Inquiries concerning the Master of Extension Education should be directed to Professor Ernest W. Anderson, 116 Mumford Hall.

FINANCE

The Department of Finance offers graduate work leading to the Master of Science and Doctor of Philosophy in Finance. The following fields are available for specialization within the department: money, credit, and banking; corporation finance; corporation history; investment; insurance; urban land utilization.

The grade-point average required for admission to graduate study in the department is 4.0, although applications of students with averages below 4.0 but above 3.75 may be considered on an individual basis. A candidate for a degree in finance must also meet the general admission requirements of the Graduate College. He must also have had (1) at least twenty-seven hours of undergraduate work in social science, fifteen hours of which must have been in economics, including a course in principles of economics, a course in statistics, and other courses for which the course in principles is a prerequisite, and (2) sufficient background in the finance area and the related fields of accountancy and business administration to support, in the judgment of the graduate adviser, the candidate's educational objective.

A candidate who elects finance as a minor for either the master's degree or the doctorate must have had (1) at least twelve hours of undergraduate work in social science, eight hours of which must have been in economics, including a course in principles of economics and other courses for which the course in principles is a prerequisite, and (2) sufficient background in the finance area and in the related fields of accountancy and business administration to support, in the judgment of the graduate adviser, the candidate's educational objective.

One year of graduate study in economic theory and a thesis are required as part of the minimum eight units for the master's degree in finance.

A candidate for the Doctor of Philosophy must pass a preliminary examination. Graduate study in accountancy or statistics, or both, is advised strongly for doctoral candidates majoring in finance.

The Doctor of Philosophy program for the first year must include (1) two units of economic theory, (2) four units of finance, and (3) two additional units in finance or related fields. Two of the finance units should be in thesis research. The second year of study includes eight units which provide (1) a concentration in finance, (2) understanding of one or more fields in economics in addition to economic theory, and (3) proficiency in any other related minor field offered.

GRADUATE FACULTY

Professors: P. M. Van Arsdell (Head of Department), C. T. Arlt, R. W. Mayer, R. I. Mehr, R. C. Osborn.
Associate Professors: W. R. Bryan, T. E. Cammack, J. W. Leonard.
Assistant Professors: J. A. Gentry, C. M. Linke.

COURSES FOR GRADUATES

420. Central Banking Policy. An examination of modern theories of monetary management, gold standard theories, central banking, fiscal policy, debt management, and their relation to monetary policy. 1 unit. ARLT.

425. The Money Market and Financial Stabilization. A study of interest rate determination; the structure and operations of the money and capital markets; the objectives and implementation of monetary, fiscal, and debt management policies. 1 unit. Prerequisite: Finance 150. ARLT.

427. Commercial Bank Management. A study of the principal policies and problems which confront top management. Major emphasis is given to liquidity, loans, investments, deposits, and capital funds, but consideration is also given to bank statements, organization structure, operations, personnel, cost analysis, and public relations. Instructional methods utilize readings, cases, and research projects. 1 unit. Prerequisite: Finance 150. BRYAN.

450. Theory of Financial Management. The objective of this course is to develop an analytical framework which represents the underlying theory of finance and its interrelationship to the total system within the firm. Necessary to this approach is the development of a perspective for both internal and external approaches to financial management. 1 unit. Prerequisite: Finance 254 or equivalent; Mathematics 132 or equivalent; Economics 470 or equivalent. LINKE.

452. Investment Behavior. Investment behavior is examined by mathematical, statistical, and behavioral science models. The models provide the basis for analyzing portfolio selection, capital market price behavior, financial institution investment behavior, and stock price behavior. 1 unit. Prerequisite: Mathematics 134 or equivalent; Economics 470 or equivalent. GENTRY.

454. Corporation Finance. Nature of corporation finance and its relation to economics, accounting, and law; development of business corporation; concepts of capital, capitalization, and capital stock; nature of equities in corporation; financial analysis and interpretation; nature and development of financial plans; corporate securities and their adaptation to financial plan; initial and promotional financing; current capital financing; income administration; refinancing. 1 unit. Prerequisite: Finance 254. VAN ARSDELL.

455. Corporation Finance. Expansion; consolidation, concentration, and intercorporate relations; the corporate institution and the problem of monopoly and competition; corporate failure and reorganization; corporate financial management and the economy. 1 unit. Prerequisite: Finance 254. VAN ARSDELL.

456. Investment. A study of the financial process by which savings are transformed into capital; theories of investment value and of portfolio composition; critique of individual and institutional portfolio policies; survey of investment literature. 1 unit. MAYER.

460. Theory of Insurance. A study of the nature and cost of risk in our economic society and of the methods of handling it. 1 unit. MEHR.

470. Risk Management and Control. Same as Business Administration 555. An analysis of the risk management problem in the business enterprise with emphasis on methodology for risk analyses, techniques for risk and loss control, models for risk management decision-making, and procedures for administering risk management policy relating to non-speculative (insurable) risk. 1 unit. Prerequisite: Business Administration 552 and 560, their equivalents, or consent of instructor. MEHR.

490. Individual Study and Research. Directed reading and research. ½ to 1 unit. STAFF.

499. Thesis Research. Required for those writing master's and doctor's theses in finance. 0 to 4 units. MEHR.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

340. Consumer Finance. Nature and importance of consumer finance; trends in consumer credit; instruments and institutions of consumer credit; economic effects of consumer finance; consumer credit and public policy. ½ to 1 unit. Extra work is required of graduate students who register for 1 unit. Prerequisite: Finance 150 and 254, or consent of instructor.

350. Capital Investment Management. Designed to develop an understanding of the complex problems related to financial management; the development of an analytical framework for capital investment decision making; the study of capital investment problems through the use of selected cases. ½ to 1 unit. Prerequisite: Finance 254. GENTRY.

357. Financing Small Business. Size and nature of small business; significance and limitations of small business; financial structure and problems; financial assistance to small business; future prospects of small business. ½ to 1 unit. Prerequisite: Finance 254 or 257. OSBORN.

359. Securities Analysis. Portfolio selection in theory and practice; application of analytical principles and techniques to fixed income securities, common stocks, and senior securities with speculative features; efficient income/risk selection of securities. ½ to 1 unit. Prerequisite: Accountancy 108; Finance 254. MAYER.

360. Employee Benefit Plans. Same as Labor and Industrial Relations 360. An analysis of the economic and financial issues involved in designing and administering employee benefit plans; major emphasis is given to group life, disability income, and medical care plans and to "qualified" pensions and profit-sharing plans for regular employees; some attention is given to special, supplementary plans for the executive employees. ½ to 1 unit. Prerequisite: Finance 260, Economics 240, or Industrial Administration 351; or consent of instructor. MEHR.

363. Estate Planning. A study of the application of life insurance to the problems of family security, business security, investments, and estate protection. ½ to 1 unit. Prerequisite: Finance 262. MEHR.

368. Survey of Urban Real Estate. A broad survey of the field of real estate and urban land economics. Particular emphasis is given to the factors determining real estate values, the techniques of real estate valuation, and the principles of land utilization, development, management, marketing, and financing. Credit is not allowed for both Finance 264 and Finance 368. ½ to 1 unit. Prerequisite: Six hours of economics or consent of instructor. COOPER.

369. Urban Land Problems. A problems course for students interested in undertaking detailed analysis of urban land problems. Problems are selected for individual study. Whenever possible the problems are selected and developed jointly with the departments of Urban Planning, Landscape Architecture, Architecture, and others. ½ to 1 unit. Prerequisite: Finance 368 or consent of instructor. COOPER.

370. Risks and Risk Management. Analysis of the financial problems in the risks of property damage or bodily injury in business situations and evaluation of the alternative methods of dealing with such problems. ½ to 1 unit. Prerequisite:

One of the following: Accountancy 105 or 201; Economics 103 or 108; Finance 254 or 257. FORBES.

371. Property and Liability Insurance. A survey course involving an analysis of (1) the insurance product, (2) financial aspects of the property-liability insurance enterprise, (3) governmental regulation of the property-liability insurance enterprise, (4) current social issues involving property-liability insurance, and (5) economic aspects of the property-liability insurance industry. ½ to 1 unit. Prerequisite: Finance 260. FORBES.

FOOD SCIENCE

(Including Dairy Technology)

The Department of Food Science offers graduate work leading to the Master of Science and Doctor of Philosophy in Food Science or Dairy Technology.

A student planning to major in food science should have a Bachelor of Science degree in a recognized field of biological, physical, agricultural, or engineering science with credit in the following specific areas: physics, eight hours; calculus, five hours; physical chemistry, four hours. Students lacking these requirements will have an opportunity to fulfill them.

In order to major in dairy technology, a student should have a Bachelor of Science degree in any of the above listed fields of science.

The grade-point average required for admission to graduate study is 3.75, but applications from students with averages below 3.75 but above 3.5 may be considered on an individual basis.

Master of Science.

Food Science. To obtain a master's degree in food science, a student must have credit in Chemistry 350 and 355 (biochemistry), Microbiology 311 and 312, and Food Science 301, 302, 421 (one-fourth unit), and 499 (two units). The remainder of the eight units of credit required for the Master of Science consist of graduate courses selected from inside and/or outside the department which, in the opinion of the student and his adviser, are appropriate for the training and development of the student in the field of his specialization.

Thesis research may be carried out in any one of the following fields of specialization: food chemistry, food engineering, food microbiology, and food processing. The student must present a thesis on his research and is required to take an oral examination covering the field of general food science and his specialization.

Dairy Technology. To obtain a master's degree in dairy technology, a student must have credit in Chemistry 350 and 355, Dairy Technology 401, 404 (one-fourth unit), and 499 (two units). A course in statistics (graduate or undergraduate) is also required.

The general provisions for a Master of Science in dairy technology are the same as in food science except that the fields of specialization apply to dairy products and the master's examination covers the field of dairy technology.

Doctor of Philosophy.

Food Science. In addition to the courses required for the Master of Science degree, candidates for the degree of Doctor of Philosophy in food science must have additional credit in Food Science 421 (one-fourth unit) and 499 (eight units). The remainder of the sixteen units of credit required for the degree will consist of graduate courses selected from inside and/or outside the department which in the opinion of the student and his adviser are appropriate for the training of the student in his field of specialization. In addition, the candidate must demonstrate proficiency in one foreign language, as approved by his adviser, in which adequate

scientific literature exists and which is neither his native tongue nor English. Also he must complete a special option approved by his adviser which may be counted as part of the sixteen required units of credit. Upon the completion of all formal courses, language and special option requirements, or during the last semester of the course work, the student is required to take a series of written preliminary examinations in food science. The final eight units after passage of the preliminary examination must be spent on thesis research. Upon the submission of his thesis, the candidate is required to defend his thesis orally before a faculty committee.

Dairy Technology. In addition to the courses required for the Master of Science degree, candidates for the degree of Doctor of Philosophy in dairy technology must have credit in Dairy Technology 403 and 404 (one-fourth unit) and 499 (eight units). They are also required to attend all seminars in dairy technology (Dairy Technology 404). The general provisions for a Doctor of Philosophy in dairy technology are the same as in food science, except that the written preliminary examinations for the doctorate are in the fields of dairy technology, dairy chemistry, and dairy microbiology.

GRADUATE FACULTY

Professors: R. T. Milner (Head of Department), J. H. Hetrick, F. A. Kummerow, A. I. Nelson, Z. J. Ordal, M. P. Steinberg, J. Tobias, S. L. Tuckey, R. M. Whitney, L. D. Witter.
Associate Professors: T. Nishida, E. G. Perkins, H. K. Wilson.
Assistant Professors: C. Argoudelis, K. A. Narayan, D. Sgoutas, L. Wei.

Food Science

COURSES FOR GRADUATES

404. Special Topics in Food Science, III: Technology of Fats and Oils. A study of the commercial technology of fats and oils, including soaps and protective coating. Offered in 1970-1971 and in alternate years. ½ unit. Prerequisite: Food Science 391 or consent of instructor. Narayan.

406. Special Topics in Food Science, IV: State and Metabolism of Lipids. An advanced study of the state of lipids in animal tissues and in biological fluids, and of the metabolism of lipids in relation to dietary fats and other food constituents. Offered in 1970-1971 and in alternate years. 1 unit. Prerequisite: Chemistry 350 or consent of instructor. Nishida.

421. Seminar. Discussions on specialized topics and current literature relating to food technology. Required of all graduate students in food science. ¼ unit. Staff.

430. Carbohydrates in Foods. Same as Home Economics 430. A study of the physical and chemical properties of carbohydrates used in foods and their behavior under conditions encountered in food processing and storage. ¾ unit. Prerequisite: Chemistry 355, 354, or 350, or consent of instructor.

440. Design and Analysis of Biological Experiments. Same as Agricultural Engineering, Agronomy, Animal Science, Dairy Science, Forestry, Horticulture, and Veterinary Medical Science 440. Statistical methods as tools for research. Principles of designing experiments and methods of analysis for various kinds of designs, including factorial experiments, are considered from the viewpoint of when and how to use them. ¾ unit. Prerequisite: Food Science 340 or equivalent.

499. Thesis Research. 0 to 4 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Special Problems. Supervised research on special problems in food science and dairy technology. ¼ to 2 units.

301. Food Processing. Lectures, discussions, and pilot-plant demonstrations and experiments in preservation of foods by canning, freezing, dehydrating, and fermenting methods. Evaluation of product quality by subjective and objective methods and consideration of factory quality control factors. Field trips to commercial food plants. 1 unit. Prerequisite: Chemistry 133; Food Science 201. NELSON, WEI.

302. Food Processing. Lectures, discussions, and pilot-plant demonstrations and experiments in food manufacture including formulation of food preparations from fruits, vegetables, and cereals; preservation of meats and poultry products; vacuum and freeze drying of foods; evaluation of product quality by subjective and objective methods and consideration of factory quality control factors. Field trips to commercial food plants. 1 unit. Prerequisite: Chemistry 133; Food Science 202 and 301. NELSON, WEI.

324. Problems in Nutrition. Same as Home Economics 324. Discussions and investigations. ½ or 1 unit. Prerequisite: Home Economics 220; Chemistry 354 or 350 and 355; senior standing.

332. Principles of Sanitation in the Processing and Handling of Foods. A study of the principles of sanitation with appropriate emphasis on practical considerations as they apply to various food processing industries. Control of insects, rodents, and micro-organisms; fundamentals of detergency; sanitation of water supplies; waste disposal methods; government and public health regulation. Local field trips to food processing plants. ½ unit. Prerequisite: Microbiology 100 and 101; Chemistry 102. ORDAL, WITTER.

340. Introduction to Applied Statistics. Same as Agricultural Engineering, Agronomy, Animal Science, Dairy Science, Food Science, Forestry, Horticulture, and Verterinary Medical Science 340. Statistical methods involving relationships between populations and samples; collection, organization, and analysis of data; techniques in testing hypotheses with an introduction to regression, correlation, and analyses of variance limited to the completely randomized design and the randomized complete-block design. ¾ unit. Prerequisite: Mathematics 104 or 111 or 112, or equivalent.

363. Introduction to Process Engineering. Same as Chemical Engineering 363. Fundamentals of heat transfer, fluid flow, evaporation, drying, and other unit operations in the process industries. For students in chemistry, engineering, and food science; not open to majors in chemical engineering. Lectures and problems. ¾ unit. Prerequisite: Calculus or consent of instructor. STEINBERG.

373. Advanced Food Microbiology. A study of the microbiology of those foods, food processes, or food ingredients, the production of which involves the biological or enzymatic activities of bacteria, yeasts, or the higher fungi. 1¼ units. Offered in 1969-1970 and in alternate years. Prerequisite: Chemistry 133; Microbiology 311 and 312. ORDAL, WITTER.

391. Special Topics in Food Science, I: Chemistry of Lipids in Foods. A detailed survey of the chemical and physical properties of lipids. Offered in 1970-1971 and in alternate years. ½ unit. Prerequisite: Credit or registration in Chemistry 350, or consent of instructor. PERKINS.

393. Special Topics in Food Science, II: Experiments in Lipid Chemistry. Laboratory exercises, demonstrations, and assigned readings. Offered in 1970-1971 and in

alternate years. ½ unit. Prerequisite: Registration in Food Science 391 or consent of instructor. ARGOUDELIS.

Dairy Technology

COURSES FOR GRADUATES

401. Advanced Principles of Dairy Technology. Study of fundamentals and fundamental problems involved in the processing of milk and milk products. 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Chemistry 350. HETRICK.

403. Colloid Phenomena of Dairy and Other Food Products. A study of the colloidal phenomena involved in the processing of dairy and other food products. 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Consent of instructor. WHITNEY.

404. Seminar. Review of current literature in dairy technology. ¼ unit; students may register for credit only twice for a maximum of one-half unit. STAFF.

499. Thesis Research. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. Dairy Plant Management. Problems in the organization, financing, labor management, and operation of dairy plants. ½ unit. Prerequisite: Consent of instructor. WILSON.

310. Dairy Product Processing. Theory and practice of receiving, preheating, pasteurizing, sterilizing, and homogenizing milk and cream for market, cultured milk and cream, powdered cream, frozen milk and cream, concentrated milk, dried milk, and ice cream. 1 unit. Prerequisite: Food Science 201; Dairy Technology 211; credit or registration in Dairy Technology 213. HETRICK.

311. Dairy Product Processing. Theory and practice of the processing and manufacture of dairy products which are relatively nonperishable, such as butter, butter oil, cheese, casein, lactic acid, lactose, and fermentation products of whey. 1 unit. Prerequisite: Dairy Technology 211 and 213. TUCKEY.

312. The Chemistry of Milk and Milk Products. Chemical composition of dairy products and the chemical changes that occur during their manufacture and storage. Offered in 1970-1971 and in alternate years. ¾ unit. Prerequisite: Chemistry 133; Dairy Technology 312 or Chemistry 122. WHITNEY.

FORESTRY

The Department of Forestry offers graduate work leading to the degree of Master of Science in Forestry. Applicants for admission must have a grade-point average of at least 3.75 for the last sixty hours of undergraduate study.

The prerequisite for graduate study is a bachelor's degree in forestry or a closely related field. Depending upon their backgrounds, non-forestry graduates may be required to complete certain basic forestry courses in addition to their regular degree requirements. Programs are designed to serve the needs of each student and to deepen his understanding of a particular phase of forestry such as ecology, economics, entomology, genetics, mensuration, physiology, soils, statistics, or wood science.

To qualify for this degree, a student must earn eight or more units of graduate credit with at least three units in courses at the 400 level. In most cases, a thesis

based on original research is required. The thesis requirement may be waived if, in the judgment of the departmental graduate faculty, such waiver will result in a better program for an individual student. Forestry seminar is required of all graduate students. Advanced courses in special interest fields are found in such areas as biometrics, botany, climatology, economics, engineering, entomology, genetics, geography, mathematics, plant pathology, and soil science (see under departmental listings).

GRADUATE FACULTY

Professors: W. R. Boggess (Head of Department), I. I. Holland, C. S. Walters.
Associate Professors: A. R. Gilmore, J. J. Jokela, R. G. Rennels.

COURSES FOR GRADUATES

400. Seminar. Discussions on specialized topics and current literature in forestry. Required of all graduate students in forestry. ¼ unit. May be taken twice for a total credit of one-half unit. Staff.

401. Special Problems. Individual studies or investigations in selected branches of forestry. ½ to 1 unit. Not more than one unit may be offered for an M.S. degree. Staff.

440. Design and Analysis of Biological Experiments. Same as Agricultural Engineering, Agronomy, Animal Science, Dairy Science, Food Science, Horticulture, and Veterinary Medical Science 440. Statistical methods as tools for research. Principles of designing experiments and methods of analysis for various kinds of designs, including factorial experiments, are considered from the viewpoint of when and how to use them. ¾ unit. Prerequisite: Forestry 340 or equivalent.

499. Thesis Research. Research may be conducted in various phases of forestry. Subject must be approved by departmental committee. 1 to 3 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

316. Environment and Tree Growth. Growth and development of forest trees as related to environmental factors, with special emphasis on micro-site changes induced by silvicultural practices. Completion of a special project required for graduate credit. 1 unit. Prerequisite: Forestry 214 or consent of instructor.

340. Introduction to Applied Statistics. Same as Agricultural Engineering, Agronomy, Animal Science, Dairy Science, Food Science, Horticulture, and Veterinary Medical Science 340. Statistical methods involving relationships between populations and samples; collection, organization, and analysis of data; techniques in testing hypotheses with an introduction to regression, correlation, and analyses of variance limited to the completely randomized design and the randomized complete-block design. ¾ unit. Prerequisite: Mathematics 104 or 111 or 112, or equivalent.

362. Forest Entomology. A study of the characteristics, life histories, and forest relationships and controls of the economically important forest insects of the United States. ½ unit. Prerequisite: One year of biological science; one year of chemistry. Rennels.

FRENCH

The Department of French offers graduate work leading to the Master of Arts, Master of Arts in the Teaching of French, and Doctor of Philosophy.

Students are admitted with a minimum grade-point average of 4.0. Applications of students with grade-point averages below 4.0 but above 3.5 are considered on an individual basis.

Students electing French as a major subject should have had a college major in French, including practical work in the use of the language and advanced work in literature. Some knowledge of other Romance languages and literatures is desirable. A reading knowledge of Latin based on three years of high school Latin or three semesters of college Latin and a reading competence in German are required for the doctorate.

Students choosing French as a minor subject are admitted to courses for which they are adequately prepared.

Master of Arts in French. In addition to fulfilling the general requirements of the Graduate College, candidates must pass an examination based on a general reading list. Candidates preparing to teach French must take French 311, 313, and 314 unless they can demonstrate proficiency.

Doctor of Philosophy in French. Candidates are expected to take at least two units in seminar courses. Candidates also are required to include two units in Old French philology, for which some knowledge of Latin is essential. These courses may be counted as a first minor subject. French 406 also is required.

Master of Arts in the Teaching of French. Candidates for the Master of Arts in the Teaching of French must earn four units in French, two units in education, and two units in electives. Requirements are French 311, 313, 314, two units; two of the following courses: History and Philosophy of Education 303, 304, 305, one unit; and Educational Psychology 311 and 312, one unit. The elective courses in French and the other electives must be selected with the approval of the adviser. The electives may be in French, in education, or, in exceptional cases, in other fields. See pages 38 and 39.

GRADUATE FACULTY

Professors: B. H. Mainous (Head of Department), F. Jost, C. A. Knudson, P. Kolb, F. W. Nachtmann, Y. Velan, C. P. Viens.

Associate Professors: P. E. Barrette, F. Bassan, Barbara C. Bowen, V. E. Bowen, H. C. De Ley, S. E. Gray, E. Jahiel, F. M. Jenkins, M. K. Myers.

Assistant Professor: L. B. Price.

COURSES FOR GRADUATES

400. Beginning French for Graduate Students. Basic grammar and vocabulary; reading practice. Designed for graduate students desiring help in preparing for the French reading requirements for the Ph.D. No graduate credit.

401. Reading French for Graduate Students. Grammar, vocabulary, general and special reading. Designed for graduate students desiring help in preparing for the French reading requirements for the Ph.D. No graduate credit. Prerequisite: French 400 or French 101 and 102, or equivalent.

405. Teaching College French. A study of the problems of teaching French at the college level, including classroom procedures and language laboratory techniques. No credit.

406. Research Methods. Orientation in graduate research, introduction to bibliographical problems, and survey of methodology for papers and dissertations. ¼ or ½ unit. Price.

Note: In any given year a selection for the following courses is offered. For current information, consult the department office or the current semester Time Table.

407. French Literary Criticism, I: History of French Literary Criticism from the Sixteenth to the Twentieth Centuries. Literary theory and practice of criticism as developed in France from the sixteenth to the twentieth centuries. Analysis and discussion of preoccupations, critical methods, and approaches to literature of representative critics, with emphasis upon emergence of philosophies of criticism. 1 unit.

408. French Literary Criticism, II: Studies in Recent French Criticism. Study of important trends in French literary criticism of the mid-twentieth century, relating these trends to critical problems and theories of literature of the late nineteenth century and the earlier part of the twentieth. 1 unit.

421. Literature of the French Renaissance. Discussion and analysis of some of the more important intellectual and religious preoccupations of the sixteenth century, as reflected in representative texts by important writers of the period. 1 unit.

424. Studies in French Poetry. Versification, poetic structure, problems of imagery and meaning, and practical work in the interpretation of individual poems. 1 unit. GRAY.

425. Explication de textes, I. Exercises according to the method of *explication de textes,* applied to texts selected principally from the period 1944-1958. 1 unit.

426. Explication de textes, II. The French method of *explication de textes* applied to selected texts of the principal French writers, in particular the *penseurs et essayistes.* 1 unit.

433. Rabelais. 1 unit. Offered in 1969-1970 and in alternate years. B. BOWEN.

434. Studies in Montaigne. A discussion of the most important aspects of Montaigne as a writer, and of his place in French literature. 1 unit.

435. Seventeenth-Century Literature, I. 1 unit. Offered in 1969-1970 and in alternate years.

436. Seventeenth-Century Literature, II. 1 unit. Offered in 1969-1970 and in alternate years.

437. Eighteenth-Century Literature, I. 1 unit. Offered in 1970-1971 and in alternate years. V. BOWEN, JOST.

438. Eighteenth-Century Literature, II. 1 unit. Offered in 1970-1971 and in alternate years. V. BOWEN, JOST.

445. Studies in Nineteenth-Century Literature, I. Studies in nineteenth-century literature to 1850. 1 unit. BASSAN.

446. Studies in Nineteenth-Century Literature, II. Studies in nineteenth-century literature after 1850. 1 unit. BASSAN.

457. Seminar in Proust, I. ½ unit. Offered in 1970-1971 and in alternate years. Prerequisite: French 342 or consent of instructor. KOLB.

458. Seminar in Proust, II. ½ unit. Offered in 1970-1971 and in alternate years. Prerequisite: French 342 or consent of instructor. KOLB.

460. Seminar in French Literature. Discussion and research on some specialized area in French literature. Topic will be announced in advance. Course may be repeated for credit. 1 unit.

462. Introduction to Romance Linguistics. See Linguistics 462. ½ unit. Prerequisite: Four semesters of a Romance language or Latin, or equivalent.

464. Du Cubisme au Surrealisme. A study of the poetic and theoretical writings of Apollinaire, Reverdy, Jacob, Breton, and Eluard. 1 unit.

465. La Littérature Contemporaine, I. In French. Twentieth-century poets and novelists. 1 unit. Offered in 1970-1971 and in alternate years. GRAY.

466. La Littérature Contemporaine, II. 1 unit. Offered in 1970-1971 and in alternate years. GRAY.

475. Introduction to Old French, I. Training in reading Old French (twelfth and thirteenth centuries), outline of Old French grammar, reading of characteristic works, outlines of literary history. 1 unit. Prerequisite: Consent of instructor.

476. Introduction to Old French, II. Training in reading Old French (twelfth and thirteenth centuries), outline of Old French grammar, reading of characteristic works, outlines of literary history. 1 unit. Prerequisite: French 475 or equivalent.

481. Old Provençal Historical Grammar. The phonology, morphology, and syntax of the Old Provençal language with emphasis on its Latin origins; illustrative reading of selected prose works. Lectures are in English. 1 unit. Prerequisite: Consent of instructor.

482. Old Provençal Literature. Selected readings of various *genres,* emphasizing lyric poetry, with attention to its position in European literature. Lectures are in English. 1 unit. Prerequisite: French 481 or consent of instructor.

483. Studies in Old French Literature. Close study of one or more topics in Old French literature. 1 unit. Prerequisite: Consent of instructor.

484. Historical French Grammar. A study of the development of the French language, principally Old French from Latin. 1 unit. Prerequisite: French 475; an elementary knowledge of Latin.

491. Individual Topics. ¼ to 1 unit. STAFF.

499. Thesis Research. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

Note: The prerequisite for all courses in this group is French 201 and 202, or equivalent.

311. French Diction. Training in the improvement of French pronunciation, with special attention to the problems of teachers. It is recommended that this course and French 313 be taken concurrently. ½ unit. Prerequisite: Consent of instructor. VIENS.

313. French Phonetics. A systematic study of the sounds and sound patterns of French. It is recommended that this course and French 311 be taken simultaneously. ¾ unit. Prerequisite: Consent of instructor. JENKINS, MYERS.

314. French Syntax. An advanced theoretical and practical study of present-day French, with some consideration of stylistics. ¾ unit. Prerequisite: French 213 and 214, or 215, or equivalent.

315. Stylistics. Linguistic analysis of a variety of French prose styles to illustrate the range of expressions for the same or similar ideas. Translation into French of fairly difficult English prose; occasional directed composition. ¾ unit. Prerequisite: French 314.

316. Structure of the French Language. Same as Linguistics 316. A general survey of the linguistic structure of modern standard French, including phonology, morphology, and syntax. Emphasis on the differences between its spoken and written forms. ¾ unit. Prerequisite: French 313 or equivalent training in phonetics. JENKINS.

335. French Civilization, I. In French. A survey of French life and French institutions, intended as a background for literary studies and as a preparation for the teaching of French. ¾ unit.

336. French Civilization, II. ¾ unit.

341. Lectures de Proust, I. *A la recherche du temps perdu.* Readings and textual explication in Marcel Proust's novel. Course covers approximately one-half of Proust's novel. ½ unit. Prerequisite: French 201 and 202, or equivalent.

342. Lectures de Proust, II. *A la recherche du temps perdu.* Readings and textual explication in Marcel Proust's novel. Course covers second half of Proust's novel. ½ unit. Prerequisite: French 341 or consent of instructor.

382. Language Laboratory Techniques. Same as German, Slavic, and Spanish 382. Instruction and practice in the techniques of making foreign-language tapes and integrating them with classroom activity; instruction in the problems of planning and operating a language laboratory. ½ unit. Prerequisite: Three years of a modern foreign language at the college level, or equivalent. MYERS.

GENERAL ENGINEERING

The courses listed below may be taken for graduate credit by students whose advisers approve their selection as satisfying part or all of the requirements for a minor for the master's degree.

GRADUATE FACULTY

Professors: J. S. DOBROVOLNY (Head of Department), B. O. LARSON, E. C. McCLINTOCK, J. E. PEARSON.
Associate Professors: R. J. PLACEK, F. L. SPALDING.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

304. Professional Expression. Reading and critical study of significant authors from Plato to W. H. Whyte, selected for their contributions to intellectual breadth, imagination, and perfection of style. Original projects allow coordination with seminar and other content courses, and permit the mature student to gain any needed knowledge of reports, administrative correspondence, and articles for publication. 1 unit. Prerequisite: Consent of instructor. McCLINTOCK.

313. Advanced Methods in Engineering Graphical Computations. Application of determinants in the theory and construction of engineering nomograms; curve fitting and formulation of empirical formulae; methods and application of graphical calculus. ½ to 1 unit. Prerequisite: Mathematics 142 or equivalent. PLACEK.

330. Industrial Standardization. Evolution and history of standardization; local, national, and international standardization; governmental standardization. Special emphasis is placed on standardization procedures for individual industrial establishments. ½ unit. Prerequisite: Consent of instructor. SPALDING.

334. Introduction to Reliability Engineering. Same as Industrial Engineering 334. An introduction to concepts in engineering design, testing, and management for highly reliable components and systems. ¾ or 1 unit. Prerequisite: Industrial Engineering 333, or Mathematics 361, or equivalent with consent of instructor.

360. Engineering Applications of Meteorological Fundamentals. The application of the fundamentals of meteorology to engineering problems including the trans-

port and diffusion of particulate matter, aerosols, and gases; precipitation processes and rainout; behavior of stack effluents, explosion debris, and radioactive materials in the atmosphere. Applications to operation scheduling and to site selection. 1 unit. Prerequisite: Mathematics 142 or 143; Physics 106, 107, and 108; Mechanical Engineering 205 and 206, or 209, or Chemistry 342 and 344, or Physics 360. PEARSON.

393. **Special Problems.** Study of advanced problems related to general engineering and graphics. ½ to 1 unit. Prerequisite: Consent of instructor. LARSON, STAFF.

GENETICS

A Doctor of Philosophy program in genetics is provided through the cooperative efforts of eight different departments of biology and is administered by the University Committee on Genetics. Training in biochemical genetics, cytogenetics, and population genetics of a variety of organisms is provided. Students seeking master's degrees are directed to the various departmental programs, or to the master's program in biology offered by the School of Life Sciences.

Applicants for admission should have at least a 4.0 grade-point average for the last sixty hours, but may be considered for admission with a 3.75 average. They should also have completed one year of college physics, quantitative and organic chemistry, trigonometry, and analytic geometry. Calculus is strongly recommended. During the first calendar year of graduate study, students are required to take an advisory examination in the major genetic areas.

During the first two years, candidates should complete courses or demonstrate proficiency in biological chemistry, calculus, statistics, cytology, cytogenetics, population genetics, quantitative genetics, and microbial genetics. All programs of study must be approved by the Genetics Committee. Students wishing a sole minor in genetics are required to complete four units of work in areas approved by the Committee and including at least three-fourths unit in a 400-level course outside the major area.

Students majoring in genetics ordinarily elect minors in one of the biology departments and in either chemistry or mathematics. Students in the genetics program are eligible for fellowships and assistantships in the participating departments and should indicate their departmental preference (Agronomy, Animal Science, Botany, Dairy Science, Horticulture, Microbiology, Psychology, or Zoology) when applying for admission.

Thesis research may be carried out under the direction of appropriate staff members in the participating departments under departmental course listings. Inquiries concerning the program should be directed to the Director of the School of Life Sciences, Professor R. E. Kallio, 387 Morrill Hall.

GEOGRAPHY

The Department of Geography offers work leading to the Master of Arts, Master of Science, Master of Science in the Teaching of Geography, and Doctor of Philosophy. At the master's level, study programs emphasize research techniques and systematic geography; individual programs for the doctoral candidates stress specialization in particular fields of systematic and regional geography, work in cognate disciplines, and encouragement of individual research.

Students applying for admission to the master's programs must have a grade-point average of 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis. All candidates for master's

degrees in geography must have an average of at least 4.25 in previous work in geography. Ph.D. candidates are expected to have at least a 4.5 average.

Additional information regarding degree program requirements may be obtained from the Head of the Department, 220 Davenport Hall.

Master of Arts or Master of Science in Geography. Successful candidates for the master's degree whose backgrounds are largely in physical geography are recommended for the Master of Science; others receive the Master of Arts. At least four of the minimum of eight units of graduate credit required for the master's degree must be in geography, and all eight may be in geography. The adviser for candidates for these degrees is Professor A. W. Booth.

Master of Science in the Teaching of Geography. Candidates for this degree must earn four units in geography, two of which are geography electives, two units in education, and two units in electives. Requirements are Geography 495, two units; two of the following courses: History and Philosophy of Education 301, 302, 303, 304, one unit; and Educational Psychology 311 and 312, one unit. Two electives must be in geography and the other two in geography, education, or, in exceptional cases, other fields. The grade-point average required for admission is 3.5. See pages 38 and 39. The adviser for candidates is Professor F. W. Foster.

Doctor of Philosophy. The doctoral student is expected to penetrate deeply into specific phases of geographic study, including one physical systematic field, one cultural systematic field, and one major region of the world. The adviser for candidates is Professor J. Thompson.

GRADUATE FACULTY

Professors: J. Thompson (Head of Department), C. S. Alexander, A. W. Booth, J. D. Fellmann, F. W. Foster, J. H. Garland, H. G. Roepke, J. A. Russell, D. B. Shimkin.

Associate Professor: J. F. Lahey

Assistant Professors: J. A. Jakle, P. D. LaValle, N. R. Nunnally.

COURSES FOR GRADUATES

412. Analytical Climatology. A detailed consideration of the character and causes of the climates of certain selected areas; the application of various criteria as bases for climatic differentiation. 1 unit. Prerequisite: Geography 111; Geography 313 or equivalent; consent of instructor. Lahey.

421. Regional Concepts in Geography. Theories of regionalism, nature of the geographic region, the unique position of regionalism in a total geographic philosophy; regionalism in applied geography. ½ unit. Prerequisite: Nine hours of regional geography. Garland.

429. The Evolution of Agricultural Economies. Same as Agronomy and Anthropology 429. The problems concerning the development of the several basic food crop economies are studied from the point of view of geographical environment, the available archaeological and ethnographic evidence, and from the point of view of agronomy and plant genetics. The regional emphasis varies from year to year. 1 unit. Prerequisite: Consent of instructor. Alexander, Staff.

461. Fundamentals of Bioclimatology. Same as Physiology 461. The effects of physical factors (such as barometric pressure, temperature, humidity, radiation, and air movement) on physiological processes in mammals; and the application of meteorological, climatological, and geographical techniques in physiological studies. ¾ unit. Prerequisite: Consent of instructor.

462. **Experimental Bioclimatology.** Same as Physiology 462. Laboratory work and demonstrations on methods of measuring meteorological factors, of clinical thermometry, and of partitional calorimetry; laboratory work on physiological adjustments of man to heat, cold, and high altitude. ½ unit. Prerequisite: Physiology 301, or 401 and 402; credit or registration in Geography 461.

463. **Historical Geography.** Objectives and methods of historical geography. 1 unit. JAKLE, RUSSELL.

464. **Advanced Human Bioclimatology.** Same as Physiology 464. Topics in human bioclimatology and medical geography, such as climatic determinism, meteorotropism, the weather elements as stresses, and acclimatization. ½ unit. Prerequisite: Geography 461.

473. **Problems in Cartography.** Subjects for map presentation are selected in the student's field of specialization or area of interest. Data are collected and maps compiled and carried to completion in final drafted form suitable for publication. 1 unit. Prerequisite: Geography 373 or consent of instructor. FOSTER.

477. **Area Analysis.** Individual analysis of areas in the vicinity of Urbana. 1 unit. FOSTER.

478. **Advanced Field Geography.** A graduate course in the theory and application of geographical field techniques to the analysis of areas, culminating in individual reports on assigned problems in the field course area. S; 1¼ to 2 units. STAFF.

495. **Advanced Studies in Geography.** Directed and supervised detailed investigation of selected problems or regions. Designed to develop ability to conduct independent investigation. ½ to 2 units. Work may be taken in the following fields:

(a) **Physical Geography, Africa, Agricultural Origins.** ALEXANDER.
(b) **Asia, Resource Management, Transportation.** BOOTH.
(c) **Urban Geography, U.S.S.R.** FELLMANN.
(d) **Middle East, Advanced Cartography, Field Methods.** FOSTER.
(e) **Anglo America, Political Geography, Regionalism.** GARLAND.
(f) **Economic Geography, Industrial Location, Europe.** ROEPKE.
(g) **Europe, Marketing Geography.** RUSSELL.
(h) **Human Ecology, U.S.S.R.** SHIMKIN.
(i) **Cultural Geography, Latin America.** THOMPSON.
(j) **Climatology, Meteorology.** LAHEY.
(k) **Geomorphology, Soils, Quantitative Methods.** LAVALLE.
(l) **Historical, Cultural, Population Geography.** JAKLE.
(m) **Remote Sensing, Quantitative Methods, Field Methods.** NUNNALLY.

497. **Development of Geographic Thought.** A consideration of the various philosophies of geography and of the men who reflect them. ½ unit. FELLMANN.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

306. **Maps and Cartobibliographical Aids.** An examination of the problems involved in the acquisitions, care, and library use of maps. Classes become familiar with the major cartobibliographical and related aids. ½ unit. Prerequisite: Consent of instructor. WHITE.

313. **Climates of the Continents.** A regional treatment of the climates of the world by continents. ¾ unit. Prerequisite: Geography 101 and 111. LAHEY.

314. **Regional Problems in Conservation of Natural Resources.** The distribution, use, and interrelationship of the resources in the various resource management

regions of the United States, the conservation techniques applied to them, and the problems of public policy in their effective management. ¾ unit. Prerequisite: A previous course in conservation, or workshop or field work training in conservation. BOOTH.

323. **Geography of the North American Midwest.** The core of the North American continent; detailed analysis of the functions and patterns of the Midlands and their external relations. ¾ unit. Prerequisite: Eight hours of geography or consent of instructor. GARLAND.

332. **Geography of South America.** A regional geography of South America with emphasis on the southern hemisphere of that continent. ¾ unit. Prerequisite: Eight hours of geography or enrollment in Latin-American studies program, or consent of instructor. THOMPSON.

342. **Geography of Europe.** Influence of climate, surface features, and natural resources on the distribution of the people, their industries, and routes of trade; new boundaries and present economic problems in their geographic setting. ¾ unit. Prerequisite: Eight hours of geography or consent of instructor. RUSSELL.

351. **Geography of Asia.** A regional geography of Asia with concentration on the monsoon realm of southern and eastern Asia. ¾ unit. Prerequisite: Eight hours of geography or consent of instructor. BOOTH.

353. **Geography of the U.S.S.R.** Physical and cultural regionalism; a survey of natural resources and patterns of human occupance including industry, agriculture, and transportation. ¾ unit. Prerequisite: Eight hours of geography, consent of instructor, or enrollment as a major or minor in Russian language and area studies. FELLMANN.

355. **Geography of Central and South Africa.** A regional geography of Africa south of the Sahara. ¾ unit. Prerequisite: Eight hours of geography or consent of instructor. ALEXANDER.

357. **Geography of the Middle East and North Africa.** A regional geography of an area with limits largely defined in terms of Arab and Moslem influences or closely related cultural and historical circumstances. The course is oriented around the strategic centrality of the core of the territory as the crossroads of Europe, Asia, and Africa. ¾ unit. Prerequisite: Eight hours of geography or consent of instructor. FOSTER.

361. **Geography of Agricultural Land Utilization.** A geographic consideration of the nature of agricultural land utilization from the world, continental, and regional viewpoints. Special emphasis is on the geographical implications of various types of agricultural land use and upon the interrelationships between areas of different types of land utilization. ¾ unit. FOSTER.

362. **Geography of Manufacturing.** An analysis of the factors bringing about geographical concentration of industry. Each of the major manufacturing regions of the world is described and analyzed in terms of the geographic conditions which have influenced its location and products. ¾ unit. Offered in 1970-1971 and in alternate years. ROEPKE.

363. **Geography of Minerals.** Geographic aspects of the mineral industries. ¾ unit. Offered in 1969-1970 and in alternate years. ROEPKE.

365. **Geography of Transportation.** A consideration of the agents of transportation (land, water, air), the routes of transportation, transportation terminal complexes, and the basic commodity exchange services of transportation within the framework of their regional interregional relationships. ¾ unit. BOOTH.

366. Location of Industry and Other Economic Activities: Theory and Practice. Locational theory applied to the relationship between geographic facts of relief, climate, resources, population, and transportation and the industrial location process; case studies in the effects of transportation networks and rates, sources of materials, labor supply, location of markets, etc., on the selection and evaluation of industrial sites; study of factors affecting location of stores and other commercial activities. ¾ unit. FELLMANN, ROEPKE.

369. Introduction to Human Ecology. Same as Anthropology, Health Education, Physiology, Psycology, Sociology, Veterinary Medical Science, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations and physiological, psychological, and sociological adjustments to environment, regulation of population, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology; one year of anthropology, geography, geology, or sociology. SHIMKIN, STAFF.

370. Quantitative Methods in Geography. Geographical applications of statistical and mathematical research techniques. ¾ unit. LAHEY, LAVALLE.

371. Introduction to Research. Introductory training in bibliographical and cartographic techniques as source materials of geographic research. Limited to geography majors. ¾ unit. FELLMANN, JAKLE, STAFF.

372. Introduction to Research. Continuation of Geography 371. The employment of a range of geographic techniques and sources leading to completion of individual papers. ½ unit. JAKLE.

373. Map Compilation and Construction. Laboratory instruction and practice in the basic techniques of map making, followed by a consideration of problems involved in the construction of maps for presentation in a reproduced form (i.e., printed, photographed). Included are the selection of proper source materials for the base and body of the map, the compilation and correlation of these materials, and methods of mechanical and photographic reproduction. 1 unit. FOSTER.

374. Problems in Human Ecology. Same as Anthropology, Health Education, Physiology, Psychology, Sociology, and Veterinary Medical Science 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multidisciplinary studies of selected current problems. 1 unit. Prerequisite: Geography, Anthropology, Health Education, Physiology, Sociology, or Zoology 369. ALEXANDER, SHIMKIN.

378. Descriptive Interpretation of Remote Sensors. Descriptive interpretation of remote-sensing images with emphasis on interpretation of aerial photography; applications of aerial photography and photographic interpretation to the solution of problems in the major field of the individual student. Two half-day field trips on Saturdays are required. 1 unit. Prerequisite: Consent of instructor. BOOTH.

381. Russian Culture History and Ethnology. Same as Anthropology 381. An historical and structural analysis of the development of Russian culture, especially the peasant traditions from Danubian to contemporary times. ½ or 1 unit. SHIMKIN.

382. Siberian Culture History and Ethnology. Same as Anthropology 382. An ecological analysis of historic and present-day Siberian cultures, with comparisons to Arctic America. ½ or 1 unit. SHIMKIN.

383. Urban Geography. The distribution, functions, and internal structure of cities; a geographic analysis and classification of urban centers and their tributary areas. ¾ unit. FELLMANN.

386. Political Geography. World patterns of nations in relation to their natural environmental backgrounds: European nations; Africa, the exploited continent; national structures in Asia; Western Hemisphere nations. ¾ unit. GARLAND.

GEOLOGY

Graduate students may take work in the Department of Geology leading to the Master of Science and Doctor of Philosophy. Candidates for the master's degree are advised to plan their work to secure a firm foundation in geology, mathematics, and in chemistry, physics, or biology rather than to specialize too narrowly. Candidates for the doctor's degree may work in the special fields of clay mineralogy, engineering geology and rock mechanics, geochemistry, geomorphology and glacial geology, ground-water geology, mineral deposits, mineralogy and petrology, oceanography, paleontology and stratigraphy, sedimentation, sedimentary petrography, structural geology, and submarine geology.

Admission requires a minimum grade-point average of 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

For graduate work in geology a student must have had (or take as a graduate student) undergraduate courses in physical geology, historical geology, mineralogy, petrology, geomorphology or surface processes, structural geology, paleontology, stratigraphy, summer field course, chemistry, physics, and calculus. He may substitute advanced courses in mathematics, chemistry, physics, or the biological sciences for certain geology courses with departmental approval.

A candidate for the doctor's degree may select a minor in chemistry, physics, mathematics, mining or civil engineering, zoology, botany, agronomy, or geography. Other minors may be chosen with departmental approval.

Additional information may be secured by writing the Head of the Department.

Master of Science in the Teaching of Earth Science. Candidates for the Master of Science in the Teaching of Earth Science must earn four units in geology; two units in other earth science areas; and two units in education including History and Philosophy of Education 304 and 305 and Educational Psychology 311 and 312.

GRADUATE FACULTY

Professors: F. A. DONATH (Head of Department), A. V. CAROZZI, C. A. CHAPMAN, C. W. COLLINSON, D. U. DEERE, J. C. FRYE, A. F. HAGNER, W. W. HAY, R. L. LANGENHEIM, G. W. WHITE.

Associate Professors: P. A. DOMENICO, D. M. HENDERSON, W. H. JOHNSON, F. D. PATTON.

Assistant Professors: D. E. ANDERSON, T. F. ANDERSON, D. B. BLAKE, J. L. EADES, N. GÜVEN, C. J. MANN, P. A. SANDBERG.

COURSES FOR GRADUATES

402. Advanced Historical Geology. Principles of interpretation and problems of earth history. 1 unit.

409. Sedimentation. 1 unit.

415. Regional Field Geology. Field study of critical localities within a geologic province during a period of two or three weeks; discussion of observations and preparation of reports in which the concepts and principles mastered in graduate study are applied to regional geologic synthesis. 1 unit. Prerequisite: Consent of instructor. LANGENHEIM.

420. **Paleoecology.** Interpretation of life habit of fossil organisms from skeletal morphology and associated depositional features; reconstruction of marine ecosystem relations from the study of assemblages of fossils. 1 unit. Prerequisite: Geology 320 or equivalent. HAY.

421. **Advanced Invertebrate Paleontology.** Intensive study of a selected invertebrate group. 1 unit. Prerequisite: Geology or Zoology 320. BLAKE.

422. **Stratigraphic Geology: Paleozoic.** The concept of the Paleozoic Era and its periods, series, stages, and zones; evaluation of the type sequences and the succession of faunas; problems of correlation and historical inference. 1 unit. Prerequisite: Geology 321 and 322. LANGENHEIM.

423. **Stratigraphic Geology: Mesozoic.** The concept of the Mesozoic Era and its periods, series, stages, and zones; evaluation of the type sequences and the succession of faunas; problems of correlation and historical inference. 1 unit. Prerequisite: Geology 321 and 322. LANGENHEIM, MANN.

424. **Stratigraphic Geology: Cenozoic.** The concept of the Cenozoic Era and its periods, series, stages, and zones; evaluation of the type sequences and the succession of faunas; problems of correlation and historical inference. 1 unit. Prerequisite: Geology 321 and 322. SANDBERG.

425. **Micropaleontology: Benthonic Foraminifera.** Classification, biology, and distribution in time and space of benthonic foraminifera; emphasis on ecology and evolution. 1 unit. Prerequisite: Geology or Zoology 320 or Zoology 318. HAY.

426. **Micropaleontology: Ostracoda.** Morphology, classification, ontogeny, and phylogeny of fossil and living Ostracoda; study of stratigraphic, paleoecologic, and ecologic distribution, and of soft part morphology. 1 unit. Prerequisite: Geology or Zoology 320. SANDBERG.

427. **Micropaleontology: Conodonts.** Morphology and history of conodonts, chitinozoans, and lesser groups with emphasis on use in biostratigraphy and paleogeography. 1 unit. Prerequisite: Geology or Zoology 320; consent of instructor. COLLINSON.

428. **Micropaleontology: Plankton.** Classification and distribution of major groups of shelled oceanic plankton; foraminifera, radiolaria, coccolithophores, diatoms, and others; emphasis is on biostratigraphic use of these fossils. 1 unit. Prerequisite: Geology or Zoology 320 or Zoology 318; consent of instructor. HAY.

430. **Crystallography.** A consideration of the approaches and techniques required for an understanding of the structures and properties of crystals, especially those of minerals; emphasis is given to the development of pattern theory, space groups, and their applications. 1 unit. Prerequisite: Geology 335 or equivalent; consent of instructor. HENDERSON.

431. **Structural Mineralogy.** Principles of the crystal chemistry and structural classification of minerals, and survey of the current knowledge about the structures and structurally dependent properties and behavior of representative minerals and mineral groups. 1 unit. Prerequisite: Geology 430; consent of instructor. HENDERSON.

432. **Geochemistry.** A chemical approach to the interpretation of geological processes with emphasis on principles which control the distribution and migration of elements in geological environments. 1 unit. Prerequisite: Geology 336 or Chemistry 321, or equivalent; consent of instructor. T. F. ANDERSON.

433. **X-ray Mineralogy.** Introduction to the principles and methods of x-ray analysis of polycrystalline mineral phases. 1 unit. Prerequisite: Consent of instructor. GÜVEN.

434. **Theoretical Petrology.** Use of thermodynamic and kinetic arguments in the solution of basic petrological problems. 1 unit. Prerequisite: Consent of instructor. D. E. ANDERSON.

435. **Igneous Petrology.** The origin and history of igneous rocks. Application of chemistry and physics to igneous petrology. In the laboratory, a study is made of selected rock suites, and special methods of petrographical investigation are covered. 1 unit. CHAPMAN.

436. **Metamorphic Petrology.** Problems in metamorphism and advanced studies of metamorphic rocks. In the laboratory, selected rock suites are studied, and special methods of investigation are covered. 1 unit. D. E. ANDERSON.

437. **Sedimentary Petrology.** A study of sedimentary petrogenesis, including erosion, transportation, deposition, consolidation, diagenesis, and lithification. 1 unit. Prerequisite: Geology 335.

438. **Sedimentary Petrography.** Microscopic study of sedimentary rocks in thin section with emphasis on textures and structures as a basis for their detailed classification and genetic interpretation. 1 unit. Prerequisite: Geology 335 and 437. CAROZZI.

440. **Mineragraphy.** Microscopic study of ore minerals including methods of identification, textures, structures, and paragenesis. 1 unit. HAGNER.

443. **Mineral Deposits.** Principles of mineral deposition and genesis of mineral deposits. 1 unit. Prerequisite: Geology 311. HAGNER.

444. **Mineral Deposits.** Structural control of mineral deposition and a study of the principal types of mineral deposits. Laboratory study of structures and of types of deposits. 1 unit. Prerequisite: Geology 443. HAGNER.

450. **Geology for Civil Engineers.** Advanced physical geology, with emphasis on the geological aspects of civil engineering. 1 unit. Prerequisite: Geology 150 or equivalent. DEERE.

455. **Hydrogeology.** The geology of the occurrence, storage, movement, and quality of water in the rocks of the Earth's crust. 1 unit. Prerequisite: Consent of instructor. DOMENICO.

461. **Mineralogy of Clays.** Same as Ceramic Engineering 461. The composition of various types of clays; the structure and properties of the clay minerals; the origin and mode of occurrence of the clay minerals and clay materials. 1 unit. Prerequisite: Geology 336 or equivalent; consent of instructor. EADES.

462. **Mineralogy of Clays.** Same as Ceramic Engineering 462. The properties of clay materials, their relation to the structure of the clay minerals, methods of determination and control; the utilization of clays in various arts and industries. 1 unit. Prerequisite: Geology 461.

471. **Submarine Geology.** General geology of the ocean basins and continental margins, with emphasis on the geological interpretation of marine geophysical investigations. 1 unit. Prerequisite: One year of physics or consent of instructor.

477. **Marine Geotechnique.** Origin and distribution of deep-sea sediments, theory and methods of sampling, mass physical and chemical properties, structural changes caused by organisms, influence of shear strength, and consolidation on diagenesis. ½ or 1 unit. Prerequisite: Geology 437 or consent of instructor.

479. **Statistical Geology.** Analysis of the geologic assumptions necessary to fulfill mathematical requirements in numerical analysis of geologic problems. 1 unit. Prerequisite: Mathematics 161 or Agronomy 240; Computer Science 101; consent of instructor. MANN.

488. Advanced Structural Geology. Analysis of geologic deformation based upon the principles of mechanics and utilizing research data from laboratory and field investigations; methods in structural analysis. 1 unit. Prerequisite: Geology 311 or consent of instructor. DONATH.

489. Geotectonics. Nature and distribution of major earth structures and geological and geophysical evidence bearing on their origin. 1 unit. Prerequisite: Geology 311 or consent of instructor.

493. Advanced Studies in Geology. ½ to 2 units. Work may be taken in the following fields:

(a) **Clay Mineralogy.** EADES, GÜVEN.
(b) **Engineering Geology.** DEERE, PATTON.
(c) **Geomorphology and Glacial Geology.** JOHNSON, WHITE.
(d) **Geotectonics.** CAROZZI.
(e) **Ground-Water Geology.** DOMENICO.
(f) **Micropaleontology.** COLLINSON, HAY, SANDBERG.
(g) **Mineral Deposits.** HAGNER.
(h) **Mineralogy and Crystallography.** GÜVEN, HENDERSON.
(i) **Paleontology.** BLAKE, HAY, LANGENHEIM.
(j) **Geochemistry.** T. F. ANDERSON.
(k) **Geophysics.** DONATH.
(l) **Petrography and Petrology.** D. E. ANDERSON, CHAPMAN.
(m) **Sedimentology.** CAROZZI.
(n) **Stratigraphy.** LANGENHEIM, MANN.
(o) **Oceanography and Ocean Engineering.** RICHARDS.
(p) **Submarine Geology.**
(q) **Structural Geology.** DONATH.

499. Thesis Research. Individual work under supervision of members of the staff in their respective fields. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Geomorphology. The study of the history, origin, and characteristics of land forms produced by fluvial, glacial, wind, and wave erosion, or by a combination of these, acting upon the major kinds of geologic materials and structures. Lectures, laboratory, and field trips. 1 unit. Prerequisite: Geology 102. WHITE.

303. History of Geology. The development of the fundamental concepts of the geological sciences from classical to modern times. 1 unit. Prerequisite: Geology 102 or consent of instructor. CAROZZI.

307. Advanced Dynamic Geology. A study of geologic processes and their effects. 1 unit. Prerequisite: Geology 102 or consent of instructor.

311. Structural Geology. Rock deformation and its results. Lectures, laboratory, and one two-day field trip. 1 unit. Prerequisite: Geology 102; General Engineering 205 or consent of instructor.

315. Advanced Field Methods. Mapping a structurally and/or stratigraphically significant area of moderate size and difficulty. Preparation of a report. ½ to 2 units. Prerequisite: Geology 215. MANN.

320. Invertebrate Paleontology. Fossil groups in biological sequence. Lectures and laboratory. Students may not receive credit for both Geology 222 and 320. 1 unit. Prerequisite: Geology 102. BLAKE.

321. Principles of Stratigraphy. Definition of stratigraphic units, correlation, facies, paleogeography, and historical inference; techniques of physical stratigraphy.

Students may not receive credit for both Geology 321 and 222. 1 unit. Prerequisite: Geology 102. LANGENHEIM, MANN.

322. Stratigraphic Paleontology. Faunal sequences in time and their use in rock correlation. 1 unit. Prerequisite: Geology 320 and 321, or consent of instructor. BLAKE.

324. Vertebrate Paleontology. Same as Zoology 324. Phylogeny, morphology, and ecology of the fossil vertebrates. Lecture, laboratory, and field trips. ½ unit. Offered in 1970-1971 and in alternate years. Prerequisite: Geology 102 or Zoology 132.

325. Paleobotany. Same as Botany 325. The structure, phylogeny, and geological distribution of representative fossil plants. Two or three field trips. 1 unit. Prerequisite: Botany 100 or Biology 100 and 101, and Geology 101; or consent of instructor.

335. Optical Mineralogy. Study of the optical properties of minerals and the use of the petrographic microscope. Emphasis is placed on the identification of minerals by the immersion method. Designed for students in geology, ceramics, chemistry, mining, and agriculture. 1 unit. Prerequisite: Geology 132. CHAPMAN.

336. Petrography. Study of the constituents, composition, textures, structures, and classification of rocks. In the laboratory, rocks are studied in hand specimen and thin section. Emphasis is placed on the ordinary methods of petrographical investigation. 1 unit. Prerequisite: Geology 335. CHAPMAN.

350. Theoretical Geophysics. An introduction to the major fields of theoretical geophysics: figure of the earth, thermodynamics of the earth, gravity, seismology, magnetism, and planetary geophysics. 1 unit. Prerequisite: Mathematics through calculus; one year of physics; Geology 311; consent of instructor.

351. Geophysical Prospecting. Same as Mining Engineering 351. Principles of geophysics and their application to mining processes. ¾ or 1 unit. Prerequisite: Consent of instructor. DE WITTE.

357. Glacial and Pleistocene Geology. Consideration of glacial flow, erosion, and deposition; stratigraphic analysis of glacial deposits and correlation of Pleistocene glacial successions with non-glacial sediments. 1 unit. Prerequisite: Consent of instructor. JOHNSON, WHITE.

360. Chemistry of the Earth. Study of geochemical processes; origin and distribution of elements and isotopes in rocks, sediments, and natural waters. ¾ unit. Prerequisite: Geology 132. T. F. ANDERSON.

370. Oceanography. Principles of biological, chemical, geological, and physical marine science. 1 unit. Prerequisite: Botany 100 or Zoology 104, Chemistry 101, Geology 101, Physics 101; or consent of instructor.

GERMANIC LANGUAGES AND LITERATURES

(Including German, Germanic, and Scandinavian)

The Department of Germanic Languages and Literatures offers work leading to the Master of Arts and Doctor of Philosophy. Students applying for admission must have a 4.0 grade-point average. Applications of students with grade-point averages below 4.0 but above 3.5 are considered on an individual basis. Students should have completed a four-year course of undergraduate study in German corresponding to that of this University. They should be familar with the principal works of German literature and be able to follow lectures in the German language. Acquaintance with

German history, philosophy, and art in their relation to the general European background is desirable.

Requirements for the Master of Arts and for the Master of Arts in the Teaching of German are detailed in pamphlets which may be obtained from the departmental office.

Fields of concentration for the Ph.D. degree are Germanic linguistics, older German literature, modern German literature, and Scandinavian languages and literature.

GRADUATE FACULTY

Professors: H. G. HAILE (Head of Department), J. R. FREY, P. M. MITCHELL, F. J. NOCK, H. STEGEMEIER.

Associate Professors: E. ANTONSEN, H. KNUST, RUTH E. LORBE.

Assistant Professors: J. MCGLATHERY, R. D. SCHIER, H. J. SCHLÜTTER, PAULINE S. SCHWALBE.

German

COURSES FOR GRADUATES

400. Beginning German for Graduate Students. Introduction to the reading of German texts in the sciences and the humanities. No graduate credit. SCHWALBE.

401. Readings in German for Graduate Students. Designed for graduate students preparing for the German reading requirements for the Ph.D. No graduate credit. Prerequisite: German 400 or equivalent. SCHWALBE.

411. Proseminar. Methods of literary criticism and research. 1 unit. MITCHELL.

412. Proseminar. Methods in German language study. 1 unit. Prerequisite: German 365 or equivalent. ANTONSEN.

415. Middle High German. 1 unit. Prerequisite: German 365. NOCK.

416. Middle High German Literature. 1 unit. Prerequisite: German 415 or equivalent. NOCK.

420. History of the German Language. 1 unit. Prerequisite: German 365. ANTONSEN.

431. German Literature of the Middle Ages. German literature from 800 to 1400. 1 unit. Offered in 1969-1970 and in alternate years.

432. German Literature from 1400 to 1700. Renaissance, Reformation, and Baroque in German literature. Lectures and readings. 1 unit. Offered in 1969-1970 and in alternate years. STEGEMEIER.

441. German Romanticism. 1 unit. Offered in 1969-1970 and in alternate years. MCGLATHERY.

442. Nineteenth-Century German Realism. 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: German 301 and 302 or equivalent.

445. Old High German. Grammar and interpretation of the oldest literary documents. 1 unit. Prerequisite: German 365. Offered in 1970-1971 and in alternate years.

451. Naturalism, Symbolism, Expressionism. German literature from the 1880's to the 1920's. 1 unit. Offered in 1970-1971 and in alternate years.

452. German Literature from the Twenties to the Present. 1 unit. Offered in 1970-1971 and in alternate years. Prerequisite: German 301 and 302, or equivalent.

460. Seminar in Older German Literature. 1 unit. Prerequisite: German 411 and 495. STAFF.

461. Seminar in Modern German Literature. 1 unit. Prerequisite: German 411 and 495. STAFF.

493. Research in Special Topics. ¼ to 2 units; may be repeated for a maximum of 2 units.

495. Bibliography and Methods of Literary History. To be taken concurrently with German 411. ½ unit. FREY.

499. Thesis Research. 0 to 4 units. ANTONSEN, FREY, HAILE, MITCHELL, STEGEMEIER.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. German Literature to 1700. ¾ unit. Prerequisite: German 210 and one other course in German literature. STEGEMEIER.

302. German Literature Since 1700. ¾ unit. Prerequisite: German 210 and one other course in German literature. FREY.

303. Advanced Conversation, Composition, and Syntax. Extensive study of advanced problems of grammar, syntax, and style. ½ unit. Prerequisite: Three years of college German including German 212, or consent of instructor.

304. Advanced Conversation. Practice in free conversation with native speaker. No graduate credit. Prerequisite: German 303 or equivalent.

305. Modern German Poetry. A political and metrical survey of modern German lyric verse. ¾ unit. Prerequisite: German 210 and one other literature course or its equivalent, or consent of instructor. LORBE.

307. The Structure of the German Language. Study of the structure of the German language with emphasis on contrastive syntax of English and German. ¾ unit. Prerequisite: German 210 and 212. RAUCH.

311. Goethe. Introduction to Goethe's life and works. ¾ unit. Offered in 1970-1971 and in alternate years. Prerequisite: German 210 and one other course in German literature. HAILE, MITCHELL.

312. Goethe's Faust. Intensive study of Goethe's *Faust,* Parts I and II. ¾ unit. Offered in 1970-1971 and in alternate years. Prerequisite: German 210 and one other course in German literature. HAILE.

320. History of German Civilization. A selected topical, historical, and pictorial analysis of German culture and civilization. ¾ unit. Prerequisite: German 210 and one other course in German literature. STEGEMEIER.

331. The Age of Lessing. ¾ unit. Offered in 1969-1970 and in alternate years. Prerequisite: German 210 and one other course in German literature. SCHWALBE.

332. Schiller. ¾ unit. Offered in 1969-1970 and in alternate years. Prerequisite: German 210 and one other course in German literature. FREY.

360. Introduction to German Phonetics. ½ unit. Prerequisite: Consent of instructor. NOCK.

365. German Phonology and Morphology. Introductory survey of the phonological and morphological structure of the German language. ¾ unit. Prerequisite: Three years of college German or equivalent. ANTONSEN.

382. Language Laboratory Techniques. Same as French, Russian, and Spanish 382. Instruction and practice in the techniques of making foreign-languages tapes and integrating them with classroom activity; instruction in the problems of

planning and operating a language laboratory. ½ unit. Prerequisite: Three years of a modern foreign language at the college level, or equivalent. MEYER.

392. Topics in German Literature. Intensive study of individual authors or other restricted topics in German literature. 1 unit. Prerequisite: Two advanced courses in German literature.

394. Introduction to Folklore: History, Theory, Methods. Same as Comparative Literature, English, Slavic 394, and Speech 346. An introduction to the study of folklore with emphasis on folk cultures in the Old and New World; an historical survey of the development of folklore study, an analysis of the methods and genres of folklore, and an introduction to field collecting and evaluation of archival materials. ¾ unit. Prerequisite: A reading knowledge of one modern foreign language is recommended.

Germanic

COURSES FOR GRADUATES

426. Gothic. An introduction to Germanic (comparative) linguistics. 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Germanic 367 or consent of instructor. ANTONSEN.

462. Seminar in Germanic Philology and Linguistics. Problems in diachronic and descriptive Germanic linguistics. 1 unit. Prerequisite: German 411 and 495 or consent of instructor. ANTONSEN.

465. Comparative Germanic Phonology and Morphology. The reconstruction of the phonological and morphological systems of Proto-Germanic and their development into the Germanic languages and dialects. 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Germanic 426 or consent of instructor. ANTONSEN.

467. Runology. A detailed analysis of inscriptions in the "older" Germanic futhark, the Anglo-Frisian futhorc, and the Scandinavian "younger" futharks; their relationships and the correlation between phonological and orthographic developments. 1 unit. Offered in 1970-1971 and in alternate years. Prerequisite: Germanic 465 or consent of instructor. ANTONSEN.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

367. Introduction to Germanic Linguistics. Same as Linguistics 367. A comparative and historical survey of the Germanic languages. ½ unit. Prerequisite: Completion of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. Some knowledge of German desirable. ANTONSEN.

Scandinavian

COURSES FOR GRADUATES

405. Old Norse-Icelandic, I. Grammar and selected readings. 1 unit. Offered in 1969-1970 and in alternate years. MITCHELL.

406. Old Norse-Icelandic, II. Readings. Selections from the Elder Edda and the sagas. 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Scandinavian 405. MITCHELL.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

361. Ibsen. The dramas in English translation; selected works of Ibsen's Scandinavian contemporaries. 1 unit. Offered in 1969-1970 and in alternate years. MITCHELL.

362. Strindberg and the Later Scandinavian Dramatists. Major dramas and prose works of August Strindberg in translation; selected plays by Kaj Munk, Kjeld Abell, Nordahl Grieg, and Pär Lagerkvist. 1 unit. Offered in 1970-1971 and in alternate years. MITCHELL.

GOVERNMENT AND PUBLIC AFFAIRS

The Institute of Government and Public Affairs renders advisory, consulting, and research services to the governments of Illinois and their elected and appointed officials. Using the data acquired in these activities, the staff seeks, through scholarly and popular publication, to advance knowledge about the science of government and the political process.

HEALTH AND SAFETY EDUCATION

The Department of Health and Safety Education offers a program of study leading to the Master of Science in Health Education. (For information regarding the degree of Doctor of Philosophy in Physical Education with specialization in health education, see page 340.) This program is centered in preparing teachers, administrators, and research workers in the general field of school health education, but also offers opportunities for preparation in the special fields of community health education and safety education.

Admission requirements for a major in this field are: (1) a grade-point average of 3.75 (although applications of students with averages below 3.75 but above 3.5 may be considered on an individual basis); (2) thirty semester hours of approved undergraduate credit in health education or closely related courses; (3) twenty-four semester hours of approved undergraduate credit in science; (4) sixteen semester hours of credit in education; and (5) a course in statistics or measurement.

Requirements for the master's degree are eight units to include: (1) four units in health education, one unit of which may be in approved courses in physical education or recreation; (2) two units in education: History and Philosophy of Education 304 and 305, and Educational Psychology 311 and 312; (3) satisfactory completion of Health Education 490, no credit; (4) presentation of an acceptable thesis in health education, two units. Candidates may petition to waive the thesis and seminar requirements but will be required to take two units in lieu of thesis credit and, in addition, to pass a final comprehensive written examination in health education. See pages 38 and 39.

GRADUATE FACULTY

Professors: H. S. HOYMAN (Head of Department), W. H. CRESWELL, JR., A. E. FLORIO, W. J. HUFFMAN.

Associate Professor: D. B. STONE.

Lecturer: C. A. BRIDGER.

Health Education

COURSES FOR GRADUATES

400. Scientific Foundations of Health Education. Designed to reinforce and extend the student's knowledge of pertinent scientific health facts and principles as these apply to the further improvement of personal, family, and community health. 1 unit. Prerequisite: Undergraduate courses beyond the elementary level in the biological and physical sciences and in health education. HOYMAN.

401. Problems in School Health Education. History, philosophy, principles, and practices of school health education in its three main phases: health service, healthful school environment, and health instruction, including evaluation. 1 unit. CRESWELL, HOYMAN, HUFFMAN, PATTERSON.

403. Problems in Public Health. Deals with the basic facts and principles of public health at the local, state, and national levels, including the relationships between public health departments, voluntary health agencies, and the school health program. ½ or 1 unit. PATTERSON, STONE.

404. Trends and Issues in Sex Education. A critical analysis of current trends and basic issues of sex education; study of present status of sex education in the United States and selected foreign countries; a critical analysis of philosophy, principles, methods, and current problems. 1 unit. Prerequisite: Undergraduate courses beyond the elementary level in the biological and social sciences, or consent of instructor. CRESWELL, HOYMAN, HUFFMAN.

490. Seminar. Student presentation of thesis reports in health and safety education; informal discussions, lectures, and critical analysis of current problems in health and safety education. No credit. Prerequisite: Health Education 495. STAFF.

493. Special Projects. Independent research. Open only to candidates for the Doctor of Philosophy. ½ or 1 unit. Prerequisite: Educational Psychology 390, Physical Education 495, and Health Education 400, or equivalent. STAFF.

495. Research Methods in Health and Safety Education. Special emphasis on research orientation and methods; experimental design; processing and analysis of data; selection of research problems and preparation of thesis; current research literature in health and safety education. ½ unit. Prerequisite: Educational Psychology 390 or equivalent. CRESWELL, HUFFMAN.

499. Thesis Research. Preparation of theses in health and safety education. ½ to 2 units. Prerequisite: Health Education 495. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

369. Introduction to Human Ecology. Same as Anthropology, Geography, Physiology, Psychology, Sociology, Veterinary Medical Science, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations and physiological, psychological, and sociological adjustments to environment, regulation of population, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology; one year of anthropology, geography, geology, or sociology. SHIMKIN, STAFF.

374. Problems in Human Ecology. Same as Anthropology, Geography, Physiology, Psychology, Sociology, and Veterinary Medical Science 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multidisciplinary studies of selected current problems. 1 unit. Prerequisite: Anthropology, Geography, Health Education, Physiology, Sociology, or Zoology 369. HOYMAN, LEVINE, STAFF.

390. Public Health Education. Theory and practice of community health education; adult health education through media such as radio, television, films, slides, posters, pamphlets, and newspapers; projects in preparing and using public health education materials; evaluation of research in public health education. ½ unit. Prerequisite: Consent of instructor. PATTERSON, STONE.

391. Public Health Statistics. An introduction to public health statistics including collection and classification of data; rates and other indices; measures of central

tendency and dispersion; tests of significance; use of vital statistics in planning, conducting, and evaluating public and school health education programs. ½ unit. Prerequisite: Mathematics 161 or Educational Psychology 390, or equivalent. BRIDGER.

392. **Health and Safety Education in the Elementary School.** An overview of the school health program designed to acquaint the teacher with modern concepts of health and safety education in the elementary school; consideration is given to the role of the classroom teacher in understanding and meeting the health needs of children; the course focuses on the legal requirements for Illinois schools, major health and safety problems of elementary children, the teacher's role in the school health program, and methods and materials in teaching modern health and safety education. ½ unit. Prerequisite: One year of biological science. STONE.

Safety Education

COURSES FOR GRADUATES

402. **Problems in Safety Education.** Philosophy of safety: traffic, recreation, home, and industrial safety facts and figures; the safety problem and its relation to education; organization of safety education programs; methods of teaching; legal aspects; research problems. 1 unit. FLORIO, HUFFMAN.

HISTORY

The Department of History offers work leading to the Master of Arts and Doctor of Philosophy degrees. Graduate work in history presupposes two years of undergraduate study in this subject, or a minimum of sixteen semester hours, including courses in European and American history. Undergraduate linguistic preparation, especially in French, German, or Russian, is important. For ancient, medieval, and renaissance history, some knowledge of Greek or Latin is essential. Spanish is useful for certain fields of European, American, and Latin-American history.

Admission to graduate study in history requires a grade-point average of at least 4.0 for the last sixty hours of undergraduate study. A student who has done graduate work in a recognized institution but without receiving a degree may petition to receive credit toward an advanced degree by passing examinations in this work.

Results of the Graduate Record Examination Aptitude Test should accompany applications for admission to the Graduate College. Information concerning the dates and places for taking this examination may be secured by writing to the Educational Testing Service, Box 955, Nassau Street, Princeton, New Jersey 08540.

Mimeographed material concerning rules in detail is available at the department office.

Master of Arts. Candidates are expected to take at least two units in two of the fields of specialization for the Doctor of Philosophy listed below. A minimum of eight units is required for the Master of Arts and three of these units must be at the 400 level. The program must include two research seminars with grades of B or better. Students may elect to write a master's thesis, but the thesis does not replace the seminar requirement. A candidate must demonstrate ability to read one foreign language related to his fields of interest as approved by the graduate advisers.

Graduate study in history may also be pursued in connection with the Master of Arts in the Social Sciences and Master of Arts in the Teaching of Social Studies (see pages 380 and 381).

Doctor of Philosophy. The Department of History offers the following fields of specialization and preparation: ancient Greece; ancient Rome; medieval to 1300; Europe, 1300-1648 (Renaissance and Reformation); Europe and dependencies, 1648-1815; Europe and dependencies since 1815; Russia; England to 1688; England and the Empire-Commonwealth since 1688; Near East and Middle East; China; Japan; South Asia; early America to 1789; United States since 1789; Latin America; History of Science; East Central Europe or Southeast Europe.

A candidate must demonstrate ability to read two foreign languages related to his fields of interest as approved by the graduate advisers. A student who has not completed the requirement in one language will not be readmitted to a second year of graduate study. No student is recommended for financial aid of any kind for a third year of study who has not fulfilled both language requirements.

Two research seminars are normally required for all candidates if these were not taken here in the master's program. History 496 and 498 also are required. The doctorate requires a minimum of sixteen units beyond the master's degree. Eight of these may be thesis research credit.

Candidates shall offer three fields in history, no more than two in the same area, for their preliminary examination. Although an adviser may require work in departments or areas other than history, such work need not be part of the preliminary examinations. A manual for graduate students in history is available from the department.

Doctoral candidates interested in specializing in American culture may elect a major in American history with a first minor, three units, in American literature, and a second minor, two units, in the history of fine arts in the United States.

Illinois Historical Survey. Graduate students have an opportunity to pursue research in connection with the Illinois Historical Survey, an organization carrying on systematic studies in the history of the Midwest. Through the use of materials collected by this survey, students in history are able to obtain useful training in the study of manuscript as well as printed materials.

GRADUATE FACULTY

Professors: C. C. Spence (Chairman of Department), W. L. Arnstein, J. L. Bates, P. P. Bernard, C. E. Dawn, W. D. Farnham, R. T. Fisher, Jr., W. Heinrichs, R. W. Johannsen, J. A. Nichols, C. E. Nowell, D. E. Queller, P. W. Schroeder, W. U. Solberg, C. G. Starr, R. P. Stearns, R. M. Sutton.

Associate Professors: R. B. Crawford, L. E. Eastman, B. D. Hill, K. A. Hitchins, F. C. Jaher, B. B. Kling, T. A. Krueger, R. M. McColley, J. B. Sirich, R. W. Waller.

Assistant Professors: J. L. Love, R. E. Mitchell.

COURSES FOR GRADUATES

403. Problems in Early Modern European History to 1815. 1 unit. Staff.

404. Problems in Modern European History Since 1815. 1 unit. Staff.

407. Problems in American History to 1865. 1 unit. Staff.

408. Problems in American History Since 1865. 1 unit. Staff.

409. Problems in Asian History. 1 unit. Staff.

411. Seminar in Ancient History: Greece. 1 unit. Mitchell, Starr.

413. Seminar in Ancient History: Rome. 1 unit. Mitchell, Starr.

415. Seminar in Medieval History. 1 unit. Queller.

417. Seminar in Renaissance and Reformation History. 1 unit.

419. Seminar in European History, 1648 to 1815. 1 unit. BERNARD, SIRICH.

421. Seminar in European History Since 1815. 1 unit. MCKAY, NICHOLS, SCHROEDER.

423. Seminar in English History to 1688. 1 unit. HILL.

425. Seminar in English and British Empire History Since 1688. 1 unit. ARNSTEIN.

427. Seminar in Russian History. 1 unit. FISHER, UROFF.

441. Seminar in Near and Middle Eastern History. 1 unit. DAWN.

443. Seminar in South Asian History. 1 unit. KLING.

445. Seminar in East Asian History. 1 unit. CRAWFORD, EASTMAN.

451. Seminar in Early American History to 1789. 1 unit. STEARNS.

453. Seminar in American History Since 1789. 1 unit. BATES, JOHANNSEN, KRUEGER, MCCOLLEY, SOLBERG, SPENCE, SUTTON, WALLER.

461. Seminar in Latin-American History. 1 unit. LOVE, NOWELL.

471. Seminar in the History of Science. 1 unit. APPLEBAUM.

496. History of Historiography. Introduction to the great historians from early times to the present. 1 unit. STARR.

497. Reading Course. Directed reading in special fields. Open only to students with a master's degree or equivalent, who are preparing for the preliminary examination in history and who need instruction in areas not provided by current course offerings. 1 unit. Prerequisite: Master's degree or equivalent; consent of instructor. STAFF.

498. Problems in the Teaching of College History. No credit. Prerequisite: Candidate for Ph.D. degree in history. STAFF.

499. Thesis Research. Individual direction in research and guidance in writing theses for advanced degrees. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

The general prerequisite for all graduate students registering in 300-numbered courses is one year of college history or consent of instructor.

301. The Middle Ages from 400 to 1100 A.D. Europe from the fall of Rome to the first crusade. ½ or 1 unit. QUELLER.

302. The Middle Ages from 1100 to 1500 A.D. Europe from the rise of towns to the establishment of national monarchy. ½ or 1 unit. QUELLER.

303. History of Byzantine Civilization. A study of cultural, religious, and social history of the Eastern Roman Empire from Constantinople's foundation in 330 A.D. to the fall of Byzantium in 1453. Special attention is given to the continuation of classical ideals and Byzantine relations with the Latin West and the Slavic and Muslim worlds. ½ or 1 unit.

304. Medieval Civilization. Religious and intellectual. ½ or 1 unit. Prerequisite: One year of college history or political science. HILL, QUELLER.

305. The Age of the Renaissance. ½ or 1 unit.

306. The Age of the Protestant and Catholic Reformation, 1500 to 1648. ½ or 1 unit. BERNARD.

307. Classical Islam: The Near East from Mohammed to the Crusades. ½ or 1 unit. DAWN.

308. The Europeanization of the Near East, 1768 to 1914. ½ or 1 unit. DAWN.

309. Development of Modern Europe: Absolutism and Colonial Expansion, 1648 to 1789. ½ or 1 unit. SIRICH.

310. Development of Modern Europe: The French Revolution and Napoleon, 1789 to 1815. ½ or 1 unit. SIRICH.

311. European History from 1815 to 1871. ½ or 1 unit. Prerequisite: One year of college history, political science, or economics. NICHOLS.

312. European History from 1871 to 1918. ½ or 1 unit. Prerequisite: One year of college history, political science, or economics. NICHOLS.

313. European History from 1918 to 1939. ½ or 1 unit. Prerequisite: One year of college history, political science, or economics. SUMLER.

314. European History from 1939 to the Present. ½ or 1 unit. Prerequisite: One year of college history, political science, or economics. SUMLER.

315. Economic and Social History of Europe to 1815. A history and analysis of the development of European economy and society from the Middle Ages to the Industrial Revolution; evolving agrarian systems; growth of commercial economies; industrial and technical progress; colonial expansion. ½ or 1 unit. Prerequisite: One year of college history or economics, or consent of instructor. MCKAY.

316. Economic and Social History of Europe Since 1815. A comparative study of the Industrial Revolution in England, France, Germany, and Russia; social, cultural, and demographic consequences of rapid economic change; expanding world economy and modern imperialism. ½ or 1 unit. Prerequisite: One year of college history or economics, or consent of instructor. MCKAY.

317. Modern Italy, 1815 to the Present. A survey of Italian political, social, economic, and cultural developments from the aftermath of the Napoleonic wars to the post-Second World War republic. ½ or 1 unit.

318. Modern European Diplomatic History, 1789 to 1890. The diplomatic history of Europe from the French Revolution to the fall of Bismarck. ½ or 1 unit. SCHROEDER.

319. Modern European Diplomatic History, 1890 to the Present. The diplomatic history of Europe from the fall of Bismarck to the present day. ½ or 1 unit. SCHROEDER.

320. Russia from the Earliest Times to Peter the Great. The political, economic, cultural, and social development of Russia during the Kievan and Muscovite periods. ½ or 1 unit. UROFF.

321. Russia from Peter the Great to 1855. The political, economic, cultural, diplomatic, and social development of Russia during Imperial times. ½ to 1 unit. RANSEL.

322. Germany Since 1890. Germany as a modern industrial society, with emphasis on the breakdown of German constitutionalism and the nature of National Socialism and the totalitarian state. ½ or 1 unit.

323. Intellectual History of Modern Europe, 1513 to 1770. A survey of the seminal ideas in the fields of political, social, and economic thought which have influenced the development of modern Europe. ½ or 1 unit. SIRICH.

324. Intellectual History of Modern Europe, 1770 to the Present. A survey of the seminal ideas in the fields of political, social, and economic thought which have influenced the development of modern Europe. ½ or 1 unit. SIRICH.

325. Intellectual and Cultural History of Russia to 1881. ½ or 1 unit. UROFF.

326. **Intellectual and Cultural History of Russia from 1881 to the Present.** ½ or 1 unit. Prerequisite: One year of college history or political science, or consent of instructor. UROFF.

327. **Russia from 1855 to the Bolshevik Revolution of 1917.** ½ or 1 unit. FISHER.

328. **History of Soviet Russia from 1917 to the Present.** ½ or 1 unit. Prerequisite: One year of college history or political science, or consent of instructor. FISHER.

329. **History of Southeastern Europe, Fourteenth to the Eighteenth Century.** The Byzantine heritage, the Ottoman conquest and its impact upon the peoples of the Balkans, and the internal political and cultural history of the Rumanians, South Slavs, Greeks, and Albanians to 1804. ½ or 1 unit. HITCHINS.

330. **History of Southeastern Europe Since 1804.** The rise of nationalism and the formation of national states in the Balkans, the decline of the Ottoman Empire, and the political and cultural history of Rumania, Yugoslavia, Bulgaria, Greece, and Albania in the nineteenth and twentieth centuries. ½ or 1 unit. HITCHINS.

332. **Medieval England.** Religious, social, intellectual, and economic developments in medieval England from the period of the Germanic invasions to the accession of the Tudors. ½ or 1 unit. HILL.

333. **Great Britain Under the Tudors and Stuarts, 1485 to 1660.** The principal political, economic, social, religious, and cultural developments in British history, including Scotland and Ireland, from the beginning of the Tudor dynasty to the Restoration of 1660. ½ or 1 unit.

334. **Great Britain Under the Later Stuarts and the Hanoverians, 1660 to 1815.** The principal political, economic, social, religious, and cultural developments in British history from the Restoration to the end of the Napoleonic wars. ½ or 1 unit.

337. **Economic History of American Agriculture.** Same as Agricultural Economics and Economics 337. The development of American agriculture from early colonial times to the present. Emphasis on regional development, evolution of methods and equipment, trends in marketing and credit, and the making of federal farm policy. ½ or 1 unit. Prerequisite: A college-level course in basic economics or American history. GUITHER.

338. **History of Cosmology.** A history of man's changing conceptions of the structure and origin of the universe from the ancient creation myths to modern times. The relationships between cosmological theories and developments in the physical sciences, philosophy, religion, and social and cultural factors are explored. ½ or 1 unit. Prerequisite: One year of college history or philosophy, or consent of instructor. APPLEBAUM.

339. **History of the British Commonwealth in the Nineteenth Century, 1783 to 1900.** ½ or 1 unit. ARNSTEIN.

340. **History of the British Commonwealth in the Twentieth Century, 1901 to the Present.** ½ or 1 unit. ARNSTEIN.

341. **Modern Britain: The Victorian Era, 1815 to 1900.** A history of the political, constitutional, social, economic, and diplomatic developments of the United Kingdom, including Ireland. ½ or 1 unit. ARNSTEIN.

342. **Modern Britain Since 1900.** A history of the political, constitutional, social, economic, and diplomatic developments of the United Kingdom, including Ireland. ½ or 1 unit. ARNSTEIN.

343. **History of Spain and Portugal.** A survey of the Iberian Peninsula from the earliest historical times to the present. ½ or 1 unit. Prerequisite: One course in college history. NOWELL.

345. Constitutional History of England to 1485. Important for those who intend to study law. ½ or 1 unit. Prerequisite: One year of college history or political science. HILL.

346. Constitutional History of England, 1485 to the Present. Important for those who intend to study law. ½ or 1 unit. Prerequisite: One year of college history or political science. HILL.

347. The Emergence of Modern Science to the Age of Newton. A history of science from ancient times to the age of Newton. ½ or 1 unit. Prerequisite: One year of college history or philosophy, or consent of instructor. APPLEBAUM.

348. The History of Modern Science Since the Age of Newton. The development of the sciences and scientific principles since the age of Newton. ½ or 1 unit. Prerequisite: One year of college history or philosophy, or consent of instructor. APPLEBAUM.

349. The Scientific Revolution, 1543 to 1727. A study of the birth of modern science in the seventeenth century, with special emphasis upon the rise of experimentalism, the growth of mathematical science, and the establishment of the mechanical philosophy. ½ or 1 unit. APPLEBAUM.

350. History of American Immigration to 1880. The migrations which peopled the English colonies and the United States and their role in the shaping of American society and culture. ½ or 1 unit. Prerequisite: One year of college history or consent of instructor.

351. History of American Immigration Since 1880. Late nineteenth- and early twentieth-century migrations and their impact on American society and culture. ½ or 1 unit. Prerequisite: One year of college history or consent of instructor.

352. Colonial Beginnings of American Life and Institutions. A study of the seventeenth- and eighteenth-century colonies. ½ or 1 unit. STEARNS.

353. American Negro History. Negroes in America from the development of the slave trade through emancipation and up to the present; emphasis is on the fifteenth- to seventeenth-century origins of modern slavery; some attention is given to slavery and emancipation throughout the Western hemisphere. ½ or 1 unit. MCCOLLEY.

354. The Era of the American Revolution, 1763 to 1789. ½ or 1 unit. STEARNS.

355. Federalists, Jeffersonians, and the Era of Good Feelings. United States history from 1789 to 1828 with emphasis on the conflict between nationalism and sectional interests. ½ or 1 unit. MCCOLLEY.

356. History of the United States, Jackson to the Civil War. Study of Jacksonian democracy; the rise of sectionalism; manifest destiny and the Mexican War; the issue of slavery and expansion and the approach of the Civil War. ½ or 1 unit. JOHANNSEN.

357. Economic History of the United States, 1775 to 1860. The growth of American economic life and institutions from the Revolution to the outbreak of the Civil War. ½ or 1 unit. SPENCE.

358. Economic History of the United States Since 1860. The growth of American economic life and institutions since 1860. ½ or 1 unit. SPENCE.

359. The Civil War and Reconstruction. Remote and immediate causes of the Civil War, especially from 1850 to 1861; problems of the North and South during the war; the consequences of the war; the efforts to create a new Union, 1865 to 1877, and the new problems created by those efforts. ½ or 1 unit. JOHANNSEN.

360. History of the United States, 1877 to 1909. ½ or 1 unit. Prerequisite: One year of college history, political science, or economics. BATES.

361. History of the United States, 1909 to 1932. ½ or 1 unit. Prerequisite: One year of college history, political science, or economics. BATES.

362. History of the United States Since 1932. ½ or 1 unit. Prerequisite: One year of college history, political science, or economics. KRUEGER.

363. Social History of Industrial America to 1890. The impact of industrialization, immigration, and urbanization on American society in the nineteenth century. ½ or 1 unit. JAHER.

364. Social History of Industrial America Since 1890. A study of the impact of industrial technology, business enterprise, immigration, and urbanization on American society. ½ or 1 unit. JAHER.

365. The History of Illinois to 1870. Evolution of a typical midwestern commonwealth, with emphasis upon its political, economic, social, religious, and cultural development in the nineteenth century. ½ unit. SUTTON.

366. The History of Illinois from 1870 to the Present. The evolution of a modern American state, with emphasis upon its political life, economic growth, social and intellectual problems, and its contributions to the American nation. ½ unit. SUTTON.

367. The Trans-Mississippi West. The history of Western expansion since the Louisiana Purchase; the West in the general history of the United States; Western economic and political problems. ½ or 1 unit. SPENCE.

368. History of the South. An inquiry into the question, when did the South begin and what have been its distinguishing traits? Special attention is given to agrarianism, industrialization, and the race problem. ½ or 1 unit. BATES.

369. Constitutional Development of the United States to 1865. ½ or 1 unit. Prerequisite: One year of college history or political science. FARNHAM.

370. Constitutional Development of the United States Since 1865. ½ or 1 unit. Prerequisite: One year of college history or political science. FARNHAM.

371. American Intellectual and Cultural History to 1877. Social and political thought, religion, science, scholarship, and education as both results and causes of American experience. ½ or 1 unit. SOLBERG.

372. American Intellectual and Cultural History Since 1877. The contribution of social and political thought, religion, science, scholarship, and education to the history of American civilization. ½ or 1 unit. SOLBERG.

373. Diplomatic History of the United States to the End of the Nineteenth Century. ½ or 1 unit. Prerequisite: One year of college history or political science. HEINRICHS.

374. Diplomatic History of the United States in the Twentieth Century. ½ or 1 unit. Prerequisite: One year of college history or political science. HEINRICHS.

375. History of Latin America to 1824. A survey of Latin-American history from the discovery of America until 1824. ½ or 1 unit. NOWELL.

376. Latin America Since 1824. A history of the Latin-American republics from their independence to the present. ½ or 1 unit. NOWELL.

377. History of Modern Brazil from 1808 to the Present. An analysis of developments from 1808, emphasizing the advances and discontinuities in the growth of a neocolonial, agricultural society into an urban, industrial polity. ½ or 1 unit. Prerequisite: One year of college history or enrollment in Latin-American studies program. LOVE.

378. History of Modern Mexico, 1765 to the Present. The development of Mexico from the Bourbon reforms of the Enlightenment to the post-revolutionary present, with emphasis on social, economic, and political change; social science concepts of economic underdevelopment, social integration, and nation-building. ½ or 1 unit. Prerequisite: Enrollment in the Latin-American studies program. LOVE.

381. Ancient Greek States. History of the Greek states from the earliest times to 334 B.C. ½ or 1 unit. STARR.

382. Alexander and His Successors. ½ or 1 unit. MITCHELL.

383. History of the Roman Republic to 44 B.C. ½ or 1 unit. MITCHELL.

384. The Roman Empire. ½ or 1 unit. STARR.

387. Indian History and Civilization to 1707. Development of Indian civilization up to the British conquest. Political evolution; religious and philosophical systems; society, art, and literature during Hindu and Muslim periods. ½ or 1 unit. KLING.

388. Development of Modern India and Pakistan from 1707. Establishment and organization of the British Empire in India; reaction of India to the Western impact; growth of nationalism and the struggle for independence. ½ or 1 unit. KLING.

389. Problems of Contemporary South Asia. Current political, economic, social, and cultural problems of India, Pakistan, and Ceylon dealt with in the perspective of the historical development of South Asia. ½ or 1 unit. KLING.

390. China Under the Ch'ing Dynasty. The period of Manchu domination in China (1644 to 1912). Emphasis is on Chinese reactions to Western influences during the nineteenth century. ½ or 1 unit. CRAWFORD.

391. A History of China to 906 A.D. A history of the formative period of the Chinese state, society, and economy. ½ or 1 unit. CRAWFORD.

392. History of China, 907 to 1644. A history of the early modern Chinese state and society prior to the Western impact. ½ or 1 unit. CRAWFORD.

393. Chinese Intellectual History from Earliest Times to the Present. A study of the major ideas and schools of thought as they have affected the course of Chinese history and the development of its institutions. ½ or 1 unit. EASTMAN.

394. Twentieth-Century China. Chinese state and society in revolutionary transition; emphasis on the Nationalist and Communist revolutions and their results. ½ or 1 unit. EASTMAN.

395. Premodern Japan. Japanese history from its origins to 1800; evolution of the traditional society, stressing institutional and cultural problems of the ancient, "feudal," and early modern (Tokugawa) period. ½ or 1 unit. PIERSON.

396. Modern Japan. Japanese history since 1800; institutional and cultural problems connected with Western pressure, the Meiji Restoration, rise and fall of empire, and creation of a modern society. ½ or 1 unit. PIERSON.

398. Intellectual History of Japan. Shinto, Buddhism, Confucianism, and Western thought as cultural and social forces in the evolution of Japan from its origins to the present. ½ or 1 unit. Prerequisite: One year of college history or philosophy. PIERSON.

HOME ECONOMICS

The Department of Home Economics offers work leading to the Master of Science or Master of Arts in Home Economics; Master of Science in Home

Economics Education; and Doctor of Philosophy in Home Economics with majors in family and consumption economics and in foods and nutrition. The major work for a master's degree in home economics may be done in one of six curricula as shown below. The minimum grade-point average for admission to graduate study in home economics and home economics education is 3.75. Applications of students with averages below 3.75 but above 3.5 are considered on an individual basis.

Master of Science or Master of Arts. Candidates for a master's degree in home economics must complete a minimum of eight units (nine if a thesis is not submitted), of which at least four must be in home economics. Four of the total units, including at least two in home economics, must be in 400-level courses.

Lists of suggested electives for each curriculum are available from the department upon request. Required courses for each of the six curricula are given below:

(1) *Child Development and Family Relationships.* A minimum of four units from Home Economics 301, 410, 418, 419, and 493 or 499.

(2) *Family and Consumption Economics.* A minimum of four units from Home Economics 313, 370, 379, 470, 499, with credit in Home Economics 370 and 499 required. A minimum of two units from Economics 300, 301, 400-401, or 402-403.

(3) *Family Housing and Household Management.* A minimum of nine units: two from Home Economics 361, 370, 375, 378, 379, and 470; Agricultural Mechanization 300, and Architecture 339; three units from Home Economics 380, 410, 418, 419, 480, 487, and 493; two units from Economics 313, Finance 369, Sociology 407, 476, 477.

(4) *Foods and Nutrition.* A minimum of four units from Home Economics 320, 322, 324, 330, 331, 422, 423, 430, 432, and 499; also, Chemistry 354, or 350 and 355 are required.

(5) *General Home Economics.* A minimum of four units from prescribed courses in three of the other five curricula in home economics.

(6) *Textiles and Clothing.* A minimum of four units from Home Economics 375, 380, 386, 388, 395, 480, 487, and 499.

Candidates for the Master of Science in Home Economics Education must earn eight units, four of them in home economics. Three of the eight units must be in 400-numbered courses and at least one of these must be in home economics. Courses in home economics are to be chosen from Home Economics 301, 320, 322, 323, 326, 330, 331, 361, 375, 378, 379, 380, 386, 388, 395, 410, 418, 419, 480, and 487; Educational Psychology 311 and 312, one unit; two of the following courses: History and Philosophy of Education 301, 302, 303, 304, one unit; Vocational and Technical Education 453, one unit; Vocational and Technical Education 456, one unit, or Home Economics 377, one-half to one unit. See pages 38 and 39.

Doctor of Philosophy. Candidates for this degree may specialize in (1) family and consumption economics or (2) foods and nutrition.

A student entering the first year of graduate study with emphasis in family and consumption economics should have had a total of fifteen hours in anthropology, economics, psychology, and sociology. Deficiency in this requirement may be made up during the first year of graduate study. Required courses include four units of family and consumption economics, two at the 400 level; two units of economic theory (400 level); two additional units of economics and/or agricultural economics (400 level); two units of anthropology, psychology, and/or sociology or one unit in these areas and Home Economics 410; and one unit of applied statistics. Additional units to bring the total to twenty-four units, of which eight must be doctoral dissertation units. Economics must be chosen as a minor field either as a sole minor or in combination with an area such as agricultural economics, anthropology, sociology, closely related areas in home economics, or an area involving international programs. A student not having an undergraduate degree in home economics

will be expected to take the second minor in a closely related area in home economics.

Candidates for the degree with emphasis in foods and nutrition must present an undergraduate foods course with an organic chemistry prerequisite; a nutrition course with organic chemistry and physiology prerequisites; adequate training in chemistry, including quantitative analysis and organic; and introductory courses in microbiology, physics, and trigonometry. A student emphasizing foods in the doctoral program should have had a course in colloid chemistry. Deficiencies in these requirements may be made up during the first year of graduate study.

Required courses include at least three units of foods and nutrition, two at the 400 level; one unit of statistical methods at the 400 level; courses in biochemistry and physical chemistry; and an advanced course in food microbiology or mammalian physiology. Additional courses in the above areas or in animal nutrition or food science are selected to satisfy major unit requirements. Candidates may minor in animal nutrition, biochemistry, food science, microbiology, physiology, and other appropriate areas. Either foods or nutrition is emphasized in research for the thesis.

Graduate students who choose an area of home economics as a minor for the Doctor of Philosophy must complete three units for a first minor or two units for a second minor in addition to credit offered for the master's degree. At least one unit must be taken in 400-level courses.

GRADUATE FACULTY

Professors: JANICE M. SMITH (Head of Department), MARILYN M. DUNSING, RUTH L. GALBRAITH, QUEENIE B. MILLS, LORRAINE D. TREBILCOCK, FRANCIS O. VAN DUYNE.

Associate Professors: MARGARET GOODYEAR, BEULAH HUNZICKER, WILLIE MAE MOWRER.

Assistant Professors: KARLYNE A. ANSPACH, ESTHER L. BROWN, BEULA V. MCKEY.

COURSES FOR GRADUATES

410. Problems in Family Living. Family relationships and their significance to the growth of family members. 1 unit. Prerequisite: Home Economics 210. MOWRER, SPORAKOWSKI.

418. Seminar in Child Development. Advanced problems in child development. 1 unit. Prerequisite: Home Economics 301. VAN DEN DAELE.

419. Seminar in Family Relationships. Critical evaluation of research literature in the field of marriage and family relationships. 1 unit. Prerequisite: Home Economics 410. MOWRER, SPORAKOWSKI.

422. Seminar in Nutrition. A study of recent literature in nutrition. ½ or 1 unit. Prerequisite: Undergraduate degree in home economics, with emphasis on foods and nutrition, or comparable background in biochemistry, microbiology, physiology, or other biological science.

423. Problems in Human Nutrition. Methods of assessing nutritional status of humans. ½ or 1 unit. Offered in 1970-1971 and in alternate years. Prerequisite: Home Economics 324 or equivalent.

430. Carbohydrates in Foods. Same as Food Science 430. A study of the physical and chemical properties of carbohydrates used in food and their behavior under conditions encountered in food processing and storage. ¾ unit. Prerequisite: Chemistry 354 or 350 and 355, or consent of instructor.

432. Seminar in Foods. Review of current literature in foods research. ½ or 1 unit.

Prerequisite: Undergraduate major in foods and nutrition, chemistry, microbiology, or physiology; consent of instructor. VAN DUYNE.

470. Seminar in Family and Consumption Economics. Same as Agricultural Economics 470. Discussion of current topics and review of the literature in family and consumption economics. ½ or 1 unit. Prerequisite: Economics 102 or 108 and a course in applied statistics; Home Economics 313, 370, or consent of instructor. DUNSING.

480. Seminar in Textiles. Current literature related to development in the production, use, and care of textile fabrics. ½ or 1 unit. Prerequisite: Home Economics 380 or equivalent; consent of instructor. GALBRAITH.

487. Seminar in Clothing. Study and discussion of research in clothing from the aspects of psychological and sociological factors contributing to the effect of clothing on the development of individuals and on family and community group reactions. ½ or 1 unit. Prerequisite: Undergraduate curriculum with majors in textiles and clothing, home economics education, home economics extension, or general home economics. ANSPACH.

493. Advanced Studies in Home Economics. Library or experimental research on specific problems of limited scope. Work may be taken in the following subjects: (a) child and family, (b) family and consumption economics, (c) family housing, (d) foods, (e) nutrition, (f) textiles and clothing. This is one of the courses which may be taken in addition to eight units required for a master's degree by students who do not write a thesis. ½ or 1 unit. STAFF.

499. Thesis Research. Work may be taken in the following subjects: (a) child and family, (b) family and consumption economics, (c) family housing, (d) foods, (e) nutrition, (f) textiles and clothing. 0 to 4 units. DUNSING, GALBRAITH, MILLS, MOWRER, J. SMITH, VAN DUYNE.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Advanced Problems in Home Guidance of Children. Emphasis is placed upon the functions and relations of routine and creative activities and the interplay of personalities in the total behavior patterns with a view to helping students understand the less obvious and more subtle aspects of child development, to differentiate between desirable and undesirable guidance procedures practiced by adult members of the family. ½ or 1 unit. Prerequisite: Home Economics 202 and 203; consent of instructor. MILLS, MOWRER.

313. Economics of Consumption. Same as Economics 313. An analysis of the macro and micro aspects of consumption. ½ or 1 unit. Prerequisite: Economics 102 or 108; a course in applied statistics. DUNSING.

320. Diet in Disease. ½ unit. Prerequisite: Home Economics 220. BROWN.

322. Physical Growth and Nutrition. Lectures, readings, and discussions. ½ unit. Prerequisite: Home Economics 220; consent of instructor. BROWN.

323. Recent Advances in Foods and Nutrition. New developments in foods and nutrition. Readings, lectures, and discussions. S; ½ unit. Prerequisite: Chemistry 102; Physiology 103; Home Economics 220 and 231.

324. Problems in Nutrition. Same as Food Science 324. Discussions and investigations. ½ or 1 unit. Prerequisite: Home Economics 220; Chemistry 354 or 350 and 355; senior standing. HASKELL.

326. Presentations: Principles and Techniques. Selection of problems and organization of materials for demonstrations and other presentations in home econom-

ics subject matter areas. Field trip; estimated cost, $15.00. ½ unit. Prerequisite: Senior standing; consent of instructor.

330. **Experimental Foods.** A consideration of the manner in which such variables as ingredients, proportions, and techniques in food preparation affect the quality of the product. ½ or 1 unit. Prerequisite: Home Economics 231; Microbiology 100 and 101.

331. **Problems in Foods.** Individual problems in food preparation and preservation. ½ unit. Prerequisite: Home Economics 330. VAN DUYNE.

345. **Institution and Restaurant Management: Food Purchasing and Equipment Selection.** Purchasing food and selecting equipment for quantity food service; factors affecting the purchase of food; relationship of floor plans and equipment to service. ½ unit. Prerequisite: Credit or registration in Home Economics 240; Economics 108. HUNZICKER.

349. **Music in Early Childhood.** Same as Music 349. A detailed consideration of the music program in nursery schools, kindergarten, and the primary grades. Topics covered include the nature of early musical responses, objectives, and experience levels of the program, methods of teaching, and materials. Observation of music teaching in the Child Development Laboratory is included in the course work. ½ unit. Prerequisite: Senior or graduate standing in music education or child development. R. SMITH.

350. **Institution and Restaurant Management: Organization and Administration.** The organization and administration of food service operations; management problems in various types of food service, personnel, costs, sanitary control. Field trips; estimated cost, $20.00 to $25.00. ½ or 1 unit. Credit is not given for both Home Economics 350 and 351. Home Economics 220 and 240. HUNZICKER.

351. **Special Problems in Group Feeding.** For individuals interested in refreshing and strengthening knowledge in group feeding. Lectures, discussions, laboratory practice in quantity food management. Food handler's certificate required. No credit for students who have completed Home Economics 240, 345, or 350. S; ½ unit. Prerequisite: Home Economics 220 and 231, or equivalent; consent of instructor.

355. **Specialized Quantity Food Production and Management.** Advanced application of food production and management principles to special food service demands. Emphasis on artistry in preparation, serving, and merchandising high quality food in quantity. ½ unit. Prerequisite: Home Economics 240, credit or registration in Home Economics 350, or consent of instructor. HUNZICKER.

361. **Development and Function of Family Housing.** Same as Agricultural Mechanization 361. Study of principles and problem solutions in family housing; basic functions, plan patterns, types, materials, and structure; economic influences, costs, and adaptations; personal and public interests. ¾ unit. Prerequisite: Home Economics 160 and 171, or consent of department. HANSEN.

370. **Family Economics.** Same as Agricultural Economics 370. Economic welfare of American families in terms of cost of living, standard of living, income, and net worth. ½ or 1 unit. Prerequisite: Economics 102 or 108; a course in applied statistics. DUNSING.

375. **Home Equipment.** A survey course in which the basic principles related to the selection, use, and care of household equipment are considered. Individual problems include an evaluation of sources of information on equipment and equipment performance tests. ½ unit. Prerequisite: Home Economics 171; six advanced hours in home economics, including one of the following: Home Economics 231, 273, 380; consent of instructor.

377. Cooperative Extension: Home Economics. The philosophy, history, and organization of the cooperative extension service. Consideration of program development, methods of presentation, and evaluation with emphasis on socio-economic characteristics of state and county. ½ to 1 unit. Prerequisite: Economics 108; Psychology 100 and Sociology 100, or Educational Psychology 211, or Agriculture 206; consent of instructor. DUNLAP.

378. Problems in Home Management. Individual investigation and reports of specific problems in the fields of family housing, home furnishings, and home management. ½ to 1 unit. Prerequisite; Home Economics 262 or 270; consent of instructor. ALEXANDER, GOODYEAR.

379. Problems in Family and Consumption Economics. Individual investigation of specific problems in the field of family and consumption economics. ½ or 1 unit. Prerequisite: Economics 102 or 108; a course in applied statistics; Home Economics 313, 370, or consent of instructor. DUNSING.

380. Advanced Textiles. The effect of the physical and chemical structures of textile fibers on their properties, manufacturing processes, use, and care. 1 unit. Prerequisite: Home Economics 183; Chemistry 102. GALBRAITH.

386. Clothing Design: Draping. Designing by draping, inspired by appropriate design sources; understanding of fitting principles through fabric manipulations; design effects maintained in garment construction. 1 unit. Prerequisite: Home Economics 285 or consent of instructor; Home Economics 286. ANSPACH.

388. Problems in Textiles and Clothing. Investigation and report of individual problems in the field of textiles and clothing. ½ or 1 unit. Prerequisite: Home Economics 286 or 380 or Marketing 211; consent of instructor. ANSPACH, GALBRAITH, TREBILCOCK.

395. Fashion Analysis. A study of fashion terminology, selected designers, garment manufacturing techniques, and methods of fashion promotion used in retail outlets. Field trip; estimated cost, $10.00. ½ unit. Prerequisite: Advertising 281; consent of instructor. TREBILCOCK.

HORTICULTURE

Graduate work is offered in the Department of Horticulture leading to the Master of Science and Doctor of Philosophy degrees. Students may specialize in any phase of horticulture including genetics, physiology, ecology, developmental anatomy, or marketing. Apiculture is offered jointly with the Department of Entomology. Well-equipped laboratories and extensive experimental farms are available for each area of specialization within the department. Special facilities available on campus include the computer laboratory, electron microscope laboratory, and radioisotope laboratory. A well-balanced program may be achieved by taking courses in agronomy (crops or soils), botany, food science, genetics, statistics, plant pathology, chemistry, bio-chemistry, entomology, or agricultural economics. Students may minor in any of these fields.

Applicants with a grade-point average of 4.0 or above for the last sixty semester credit hours of course work for the bachelor's degree are admitted for graduate study in horticulture. Applicants with an average below 4.0 but above 3.75 are considered on an individual basis. Applicants should have adequate preparation in the fundamental sciences.

A minimum of eight units must be completed for the master's degree. A candidate for the degree of Doctor of Philosophy must complete eight units of courses beyond the master's degree, satisfy the language requirements, and pass an oral preliminary examination. The candidate must also complete eight units of thesis research and submit an acceptable thesis.

Additional information concerning specific requirements and opportunities in graduate research is available from the Head of the Department of Horticulture, 125 Mumford Hall.

GRADUATE FACULTY

Professors: C. J. Birkeland (Head of Department), C. Y. Arnold, J. R. Culbert, D. F. Dayton, J. B. Gartner, M. B. Linn, J. P. McCollum, D. Powell, R. K. Simons, A. E. Thompson, J. S. Titus, J. S. Vandemark.

Associate Professors: L. Beevers, D. B. Dickinson, T. K. Hodges, E. R. Jaycox, A. M. Rhodes, C. C. Zych.

Assistant Professors: J. D. Butler, H. J. Hopen, M. M. Meyer, W. E. Splittstoesser.

COURSES FOR GRADUATES

424. Mineral Nutrition of Plants. Same as Agronomy and Botany 424. A study of the uptake, transport, and metabolic utilization of mineral nutrients by plants. The scope of the course is to present the essentiality of various anions and cations in the light of metabolic activity and constituency in functional plant compounds. Major emphasis is placed on metabolic activity and function of the elements. 1 unit. Prerequisite: Botany 330 or consent of instructor. Hageman.

440. Design and Analysis of Biological Experiments. Same as Agricultural Engineering, Agronomy, Animal Science, Dairy Science, Food Science, Forestry, and Veterinary Medical Science 440. Statistical methods as tools for research. Principles of designing experiments and methods of analysis for various kinds of designs, including factorial experiments, are considered from the viewpoint of when and how to use them. ¾ unit. Prerequisite: Horticulture 340 or equivalent.

447. Horticulture Seminar. Discussion of current research and literature pertaining to problems of horticulture and related fields. ¼ unit. Staff.

490. Research Methods in Horticulture. Lectures, discussions, demonstrations, and laboratory exercises dealing with methods and apparatus used in horticultural research. 1 unit. Prerequisite: Chemistry 133 or equivalent; Chemistry 122 or equivalent; Botany 330; five hours of physics. Staff.

492. Special Topics in Horticulture. Readings and discussions in selected phases of horticulture including such topics as genetics, physiology, anatomy, morphology, and ecology of horticultural crops. ½ to 2 units. Prerequisite: Twenty hours of undergraduate work in horticulture and allied subjects for a major and twelve hours for a minor. Staff.

499. Thesis Research. Research on the thesis problem in floriculture, fruit breeding, pomology, and vegetable crops. Required in horticulture major. 0 to 4 units. Prerequisite: Twenty hours of undergraduate work in horticulture and allied subjects for a major and twelve hours for a minor. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

321. Floricultural Physiology. A study of the physiology and metabolism of floricultural crops during their development from seeds through flowering. Lectures and discussion. 1 unit. Prerequisite: One semester of organic chemistry and introductory plant physiology, or equivalent. Beevers.

322. Plant Nutrition. A study of the mechanisms of and factors affecting the absorption, transport, and functions of the essential elements required by

higher plants. Lectures, discussions, and laboratory. 1 unit. Prerequisite: One semester of organic chemistry and introductory plant physiology, or equivalent. HODGES.

323. Principles of Plant Breeding. Same as Agronomy 323. Genetic and cytological variation in crop plants, the production and control of such variation in developing varieties and hybrids, the maintenance of high quality seed stocks. Field trips; estimated cost, $5.00. 1 unit. Prerequisite: Agronomy 110 or equivalent; Botany 100. HADLEY, HITTLE, THOMPSON.

335. Economics of Food Distribution. Same as Agricultural Economics 335. Analysis of (1) marketing structures and operations in the manufacture and wholesale and retail distribution of food; (2) effects of industry organization and governmental regulations on marketing functions and efficiency; (3) consumer demand for food. ¾ or 1 unit. Prerequisite: Economics 108; Agricultural Economics 230 or an elementary marketing course. KELLY.

340. Introduction to Applied Statistics. Same as Agricultural Engineering, Agronomy, Animal Science, Dairy Science, Food Science, Forestry, and Veterinary Medical Science 340. Statistical methods involving relationships between populations and samples; collection, organization, and analysis of data; techniques in testing hypotheses with an introduction to regression, correlation, and analyses of variance limited to the completely randomized design and the randomized complete-block design. ¾ unit. Prerequisite: Mathematics 111 or 112 or 104, or equivalent.

345. Growth and Development of Horticultural Crops. Factors affecting growth, development, and quality of vegetable crops. Lecture and discussion. 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Botany 330 or equivalent, or consent of instructor. MCCOLLUM.

361. Individual and Group Behavior of Honey Bees. Same as Entomology and Zoology 361. Study of individual and group behavior of honey bees, their biological value, physical basis, and evolution. Lectures and discussions, one or more local field trips, term paper, and assigned reading. ½ unit. Prerequisite: One semester of entomology or zoology. JAYCOX.

HUMANITIES

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

363. Introduction to Comparative Literature, I. Same as Comparative Literature 363. A one-year course in two parts, offering a survey of methods and goals of comparative literature, illustrated by representative examples taken from several literatures and studies of modern criticism. ¾ unit.

364. Introduction to Comparative Literature, II. Same as Comparative Literature 364. Continuation of Humanities and Comparative Literature 363. ¾ unit.

INDUSTRIAL ADMINISTRATION

See Business Administration, page 103.

JOURNALISM

The Department of Journalism offers graduate work leading to the Master of Science in Journalism. For the program leading to the Doctor of Philosophy in Communications, see page 142.

Admission to graduate work in journalism requires (1) completion of the requirements for a bachelor's degree in an institution of recognized standing, preferably with a major (normally twenty semester credit hours) in journalism or a related field such as English or the social sciences; and (2) a grade-point average of at least 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

Requirements for the master's degree include:

(1) A major of four units, or three units and one additional unit approved by the department. Candidates without acceptable undergraduate majors may be required to complete (a) one unit of Journalism 321, (b) one unit of advanced undergraduate courses in writing or editing, and (c) in individual cases, some combination of Journalism 204, 211, 223, and 291, without graduate credit.

(2) A minor of at least two units, normally in an area outside the College of Communications.

(3) A thesis of one unit (Journalism 499) or the preparation of a topic of general public interest for publication or broadcast (Journalism 490).

(4) A minimum of three units in courses at the 400 level, at least two of which must be in the major field.

(5) A comprehensive written examination in the student's major and minor fields and on the current master's reading list.

(6) A minimum total of eight units.

GRADUATE FACULTY

Professors: J. W. JENSEN (Head of Department), T. PETERSON.
Associate Professors: J. W. CAREY, G. G. HANSON, H. S. MACLAY, J. H. SCHACHT, H. I. SCHILLER.
Assistant Professors: T. H. GUBACK, NANCY WIGGINS.

COURSES FOR GRADUATES

468. The Political Economy of Communications. Same as Communications 468. Analysis of the structure, policy, and behavior of such media of communication as newspapers, magazines, books, postal service, telegraph, telephone, broadcasting, and film, with special emphasis on their relationships to political order and the economy. 1 unit. GUBACK.

470. Communications and Popular Culture. Same as Communications 470. Problems of cultural analysis related to the media of communications; social implications of communications research. 1 unit. CAREY, GUBACK, SCHACHT.

471. Proseminar in Communications, I. Same as Communications 471. A general discussion of the mass media of communications, their role as social institutions, their control, and support; content, audience, and effect of the mass media. 1 unit. CAREY, STAFF.

472. Proseminar in Communications, II. Same as Communications 472. A general discussion of the problem of communications, including the individual as a communicating system, symbolic processes, analysis of messages, psycholinguistics, and language as social behavior. 1 unit. MACLAY, STAFF.

473. History and Theory of Freedom of the Press. Same as Communications 473. Development of the Anglo-American press system and the idea of freedom of the press; contemporary mass media and their implications for freedom and democracy. 1 unit. JENSEN.

474. Communications Systems. Same as Communications 474. Analysis of the structure and development of communications systems; examination of the role of

communication in social change, political movements, and formal organizations. 1 unit. CAREY, SCHILLER.

490. **Special Topics in Journalism.** ½ or 1 unit. Prerequisite: Consent of head of department. STAFF.

492. **Research Methods in Communications.** Same as Communications 492. An introduction to the methods of empirical research in the behavioral sciences applicable to research problems in human communication, with emphasis on studies of mass communication. Lectures, readings, and laboratory practice. 1 unit. Prerequisite: An introductory statistics course or consent of instructor. WIGGINS.

499. **Thesis Research.** 1 to 2 units. Prerequisite: Graduate standing in journalism. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. **High School Journalism.** Journalistic writing in the high school; newspaper study and training of newspaper readers; supervision of school publications and publicity; junior college courses in journalism. ½ unit. Prerequisite: Consent of instructor. GILMORE.

310. **Typographic Disciplines of the Book.** Same as Library Science 310 and English 392. The study of the book as a manufactured object, with emphasis upon practices and methods in continuous use from the Renaissance to the present, including type faces, paper, binding, and illustration. Extensive practicum in the typographic laboratory. ½ unit. Prerequisite: Consent of instructor.

321. **News Editing.** Newspaper desk work; editing the news; correction of faulty news stories; handling wire copy. Attention to headwriting, news pictures, and make-up and design of newspaper pages. 1 unit. Prerequisite: Credit or registration in Journalism 204; Journalism 212 or consent of instructor. GILMORE, PUFFENBARGER, SCHACHT.

323. **Advanced Reporting.** Advanced types of news investigation and treatment. ½ unit. Prerequisite: Journalism 211 and 212, or equivalent. PUFFENBARGER.

326. **Magazine Article Writing.** Preparation of feature stories and articles; techniques of marketing, market analysis, and publishing articles written in the course. ½ unit. Prerequisite: Journalism 211 or consent of instructor. GRAHAM, SCHACHT.

327. **Special Topics in Twentieth-Century Journalism.** Special topics, particularly on recent developments in such areas as radio, advertising, television, and modern magazines. ½ unit. Prerequisite: Journalism 211 or consent of instructor.

329. **The Rhetoric of Journalism.** Studies in journalistic method, involving principally the analysis of structure and writing style as related to purpose. Materials are drawn from English and American journalism from the seventeenth century to the present, but emphasis is on work published in twentieth-century American newspapers and periodicals. ½ unit. Prerequisite: Journalism 211 or consent of instructor. SCHACHT.

330. **Magazine Editing.** Basic principles of editing for consumer, business, trade, and company magazines; communications theory, market analysis, editorial process, design process, production process, and distribution process as they relate to magazine publishing. ½ unit. Prerequisite: Credit or registration in Journalism 326. SCHACHT.

341. **Newspaper Management.** Principles and methods in the operation of daily and weekly newspapers; managerial problems of the editorial, advertising, circula-

tion, and commercial printing departments; plant operation. ½ unit. Prerequisite: Credit or registration in Journalism 204.

344. **Community Newspaper Publication.** Study of weekly and small- and medium-sized daily newspapers in handling news, editorials, features, pictures, and correspondence; and in meeting business, circulation, and advertising problems. Includes one or more field trips for each student, with actual work on a small newspaper. ½ unit. Prerequisite: Journalism 212 or consent of instructor. GILMORE.

LABOR AND INDUSTRIAL RELATIONS

The Institute of Labor and Industrial Relations offers a Master of Arts and a Doctor of Philosophy in Labor and Industrial Relations. Graduate instruction is offered in trade union and management organization, in the accommodation of these organizations through the process and structure of collective bargaining, in personnel administration and employee relations, in the role of the government in legislating labor standards and labor relations, and in the formulation of public policy. These matters are studied in the context of social, economic, and political change and are analyzed with the help of theoretical and empirical formulations of economics, history, law, political science, psychology, and sociology.

Master of Arts. A student seeking admission to the Institute's master's program must meet the general entrance requirements of the Graduate College. In addition, the faculty reviews the undergraduate record of every candidate and may refuse admission to a student whose record indicates inadequate preparation. Prerequisites are courses in labor problems and statistics; course work in the various social sciences is desirable preparation for the Institute program.

Candidates for the master's degree have a choice of study programs. Program A requires eight units of graduate credit, two of which are granted for successful completion of a thesis. Program B requires ten units of course work and successful completion of both written and oral comprehensive examinations.

Doctor of Philosophy. Admission to the doctoral program is granted only to those students whose undergraduate and graduate records indicate that they are likely to complete successfully the requirements for the Ph.D. Admission requirements are a master's degree or equivalent in labor and industrial relations or an allied field, a master's thesis or similar evidence of research competence, and three letters of recommendation. Prerequisites are courses in labor problems, statistics, and college algebra; first-year calculus is recommended. Minimum preparation in the social sciences is an undergraduate major in economics, history, political science, psychology, or sociology, or at least nine hours in each of two social sciences.

The candidate's course work is concentrated in two or more social science disciplines related to a selected area of specialization; in addition, five units of course work in industrial relations theory and methodology are required. The candidate may select one of the following four areas for specialization: (1) industrial relations systems and public policy; (2) wages, labor market behavior, and income security; (3) labor and management organizations and labor-management relations; (4) interpersonal and administrative behavior.

Students taking master's or doctoral degrees in other departments—economics, industrial administration, communications, history, political science, psychology, sociology, and others—may arrange a minor in labor and industrial relations.

Full details of the Institute program and requirements are given in the publication, *Graduate Study at the Institute of Labor and Industrial Relations,* which may be obtained by writing to the Institute of Labor and Industrial Relations.

GRADUATE FACULTY

Professors: M. Rothbaum (Director of the Institute of Labor and Industrial Relations), M. Derber, W. H. Franke, P. L. Garman, B. Karsh, W. McPherson, A. F. Sturmthal, H. C. Triandis, M. Wagner.
Associate Professors: H. Folk, P. T. Hartman, C. L. Hulin, V. L. Stoikov.
Assistant Professor: G. B. Graen.

COURSES FOR GRADUATES

418. Seminar in Industrial and Economic Sociology. Same as Sociology 418. Discussion and individual research on such topics as industrialization, labor-management relations as group relations, the interrelations of industry and community, technology and the structure of controls in industry, and the problem of a social economics. 1 unit. Prerequisite: Labor and Industrial Relations 318 or consent of instructor. Karsh.

420. Formation of Public Policy. Same as Political Science 420. An examination of the institutional and dynamic forces that shape the making of policy and its administration in the United States; separation of powers, pressure groups, administrative and legislative procedures, and judicial activity. 1 unit.

435. Motivation and Morale in Industry. Same as Psychology 435. Concepts and methods in the study of motivation of employees; determinants of employee attitudes and job satisfaction; modification of attitudes and morale. 1 unit. Prerequisite: Four units of graduate credit in psychology or consent of instructor. Nealey.

440. Labor Economics. Same as Economics 440. A survey of recent trends in the labor force, of real and money earnings, and of the distribution of national income. This review of recent trends in these areas is used as the basis for a critical economic analysis of contemporary English and American wage theory. 1 unit. Prerequisite: A minimum of six hours of economics.

441. Labor Economics. Same as Economics 441. The economic issues and implications involved in hours of work, employment and unemployment, and trade union institutionalism (the impact of the trade union upon the basic institution of a free enterprise economy). Emphasis in all cases is upon the development of appropriate public policy. 1 unit. Prerequisite: A minimum of six hours of economics.

442. Collective Bargaining. Same as Economics 442. The development of a theory of the continuing interactions between union and management which define and modify the role of each and the terms of employment. Appropriate social science concepts are used. Emphasis is on the negotiating process, the structure of bargaining, and such issues as wages, worker security, and management authority as well as on the interactions between the parties and the governmental process. 1 unit. Prerequisite: Consent of instructor.

443. Problems and Practices of Labor Dispute Settlement. Same as Economics 443. Seminar in the policies and practices of labor contract administration; comparative study of the fundamentals of grievance handling; analysis of mediation and fact-finding techniques; and special emphasis on the use of arbitration as a means of reducing industrial conflict. 1 unit. Prerequisite: Consent of instructor. McPherson.

444. Economics of Manpower Resources. Same as Economics 444. Emergence of the manpower resource issue; population as a resource base; the labor force; measurement and characteristics, behavior under changing income, employ-

ment, technology; women as the dynamic factor in labor force growth; problems of utilization of labor force components; intellectual resources, older workers, manual, white collar, Negro, marginal forces; issues of national manpower policy. 1 unit. Prerequisite: Consent of instructor. PARRISH.

445. **Investment in Human Resources.** Same as Vocational and Technical Education 445. Activities which influence future monetary and psychic income by improving the resources in people. The investments covered include schooling, on-the-job training, medical care, migration, and the search for information on prices and incomes, with main emphasis on education. A last section covers educational planning. 1 unit. Prerequisite: An introductory course in economics and in quantitative methods.

446. **Foreign and International Labor Movements.** History and organization, economic and political policies of the major labor movements in the world; their international organizations; comparative analysis of particular problems confronting these movements; labor movements in underdeveloped areas; labor and economic development; labor under totalitarian regimes. 1 unit. Prerequisite: Consent of instructor. STURMTHAL.

447. **Labor Union Organization and Administration.** Same as Economics 447. Analysis of the structure, functions, and government of the modern American trade union movement. Provides a survey of the environmental factors, objectives, and action programs with considerable emphasis on economic as well as internal institutional factors, including the roles of leaders, policy determination and execution, jurisdictional disputes, and governmental regulations. 1 unit. Prerequisite: Major in social science or consent of instructor. GARMAN.

448. **Problems of Personnel Management.** Same as Industrial Administration 448. An examination of the organization and administration of the personnel function in management. The course deals with the relations of personnel administration to operating departments, and the scope of business and industrial personnel services. Analytical appraisal of policies and practices in selected areas of personnel administration, such as selection and training, is carried out through case studies and direct industrial contacts. Specific consideration is given to problems up to and including placing the person on a job. 1 unit. Prerequisite: Industrial Administration 248 or equivalent, or consent of instructor.

449. **Problems of Personnel Management.** Same as Industrial Administration 449. A seminar and laboratory course dealing with the problems and practices encountered by personnel managers subsequent to the employment process. Students do field work in businesses and industries in the area on such topics as incentives, rating, employee services, and community relations. 1 unit. Prerequisite: Labor and Industrial Relations 448 or equivalent.

450. **Management and Industrial Relations.** An analysis of the industrial relations function in management. Using case problems, research reports, and theoretical analyses, an examination is made of the development of the industrial relations function, alternate organizational approaches in dealing with employees and unions, the formation of labor relations policies, and management responsibilities in industrial relations. 1 unit. Prerequisite: Consent of instructor.

490. **Individual Topics.** A student in labor and industrial relations may register for this unit with the consent of his curriculum adviser and the adviser under whom he will perform the individual study or research. Such individual work may include special study in a subject matter for which no course is available or an individual research project, including on-the-job research in industry, which is not being undertaken for a thesis. 0 to 2 units. STAFF.

492. Readings in Labor and Industrial Relations. Readings and analysis of important works in the field of industrial relations. The course is designed to emphasize the differing but complementary approaches of several social sciences to industrial relations problems. The interdisciplinary approach is sought both through selection of readings and through the participation of various Institute staff members in discussions dealing with their special interests. 1 unit. Prerequisite: Consent of instructor.

493. Research Seminar in Labor and Industrial Relations. Systematic analysis of theories and procedures of the various social and physical sciences bearing on research in labor and industrial relations. Primary emphasis is on the process of integrating the approaches and techniques of the various social sciences with respect to the study of problems in labor and industrial relations as met in practice in management, the union, and government service, as well as in teaching and research in the field. 1 unit. Prerequisite: Major in social sciences or consent of instructor. DERBER, FRANKE.

494. The Major Theorists of Industrial Relations. An integrated analysis of the principles of labor relations through the study of the works of the major theorists and their critics. 1 unit. Prerequisite: Consent of instructor. DERBER.

495. Application of Theory to Contemporary Problems in Labor and Industrial Relations. A seminar for advanced graduate students in the application of social science and industrial relations theory and research methodology to selected contemporary problems. Seminar discussions focus on work developed by the seminar members. 1 unit. Prerequisite: Labor and Industrial Relations 493 and 494, or consent of instructor.

496. The Evolution of Labor-Management Relations in America. Analysis and interpretation of the development of labor-management relations at the plant and industry levels from the stages of master and servant and master and journeyman in colonial times to the stage of constitutional government and industrial democracy in the present day. 1 unit. Prerequisite. Graduate standing in labor and industrial relations or consent of instructor. DERBER.

498. Analysis of Organizations in Industrial Relations. An intensive analysis of organizational behavior, with the main focus upon the theory of organizations as social institutions. Concepts are drawn from the various social sciences and applied to the principal organizations concerned with industrial relations. The internal dynamics of unions, managements, and government agencies are examined, with special reference to decision-making processes, and are related to the interactions among them. 1 unit. Prerequisite: Consent of instructor. LEVINE.

499. Thesis Research. For all students writing theses in labor and industrial relations. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

318. Industry and Society. Same as Sociology 318. Introduction to the sociology of economic institutions; selected problems of technological change and industrialization; corporate organization and trade union structure; human relations in industry and the changing bases of managerial authority; changing consumption patterns and the redefinition of work and leisure. ½ or 1 unit. Prerequisite: Six hours of sociology including one of the following: Sociology 218, 223, 300, 322, 326, or consent of instructor. KARSH.

321. Industrial Social Systems, I. Same as Industrial Administration 321. Particular forms of individual and group behavior in organizations within the constraints of the economic, social, technological, and physical environment; the relations

between union and management; the interdependency of these factors with the decisions managers make. ½ to 1 unit. Prerequisite: Industrial Administration 210; Psychology 100; Psychology 201 or consent of instructor.

342. Economics of Social Security. Same as Economics 342. A critical analysis of the economic issues and problems involved in our legislative efforts to reduce the economic risks of unemployment, old age dependency, and industrial injuries. ½ or 1 unit. Prerequisite: Economics 103 or 108.

344. The Law and Labor. Same as Economics 344. An economic analysis of the problems and issues arising out of the legislative and judicial efforts to define the rights, duties, and responsibilities of labor organizations and management in the field of industrial relations. ½ or 1 unit. Prerequisite: Economics 103 or 108; Economics 240.

347. Labor Law, I. Same as Law 347. The law of industrial relations with special emphasis on recent cases and legislation; the establishment of the collective bargaining relationships; strikes, boycotts, and picketing; Federalism and labor relations. 1 unit.

355. Industrial Social Psychology. Same as Psychology 355. Social psychological research and theory applied to industrial problems. Emphasis upon interaction and communication theory, role theory, leadership theory, motivational and perceptual theory, and group structure theory as an aid to understanding and analyzing industrial problems. ½ or 1 unit. Prerequisite: Psychology 255 or Labor and Industrial Relations 357. TRIANDIS.

357. Psychology of Industrial Conflict. Same as Psychology 357. An analysis, in terms of the behavior of individuals, of the causes and possible solutions of industrial conflict. ½ or 1 unit. Prerequisite: Psychology 100 or equivalent. Offered in special interest of industrial relations, commerce, and engineering students. HULIN.

360. Employee Benefit Plans. Same as Finance 360. An analysis of the economic and financial issues involved in designing and administering employee benefit plans; major emphasis is given to group life, disability income, and medical care plans, and to "qualified" pensions, and profit-sharing plans for regular employees; some attention is given to special, supplementary plans for the executive employees. ½ to 1 unit. Prerequisite: Finance 260, Economics 240, or Industrial Administration 351; or consent of instructor.

365. Government and Labor. Same as Political Science 365. Critical analysis of the relationship between group pressures on government and public policy affecting labor; role of administration in formation of policy; problems and experience of federal agencies operating in the labor fields. ½ or 1 unit. Prerequisite: Political Science 150 or 191.

LANDSCAPE ARCHITECTURE

The Department of Landscape Architecture offers work leading to the Master of Landscape Architecture degree. Areas of study interest are urban design, landscape resources, and professional education. A pamphlet giving detailed information on the program is available upon request.

Candidates for admission must possess a bachelor's degree in landscape architecture or related fields. Those whose undergraduate work is not substantially equivalent in scope and standards to that of the Department of Landscape Architecture at the University of Illinois must expect to complete prerequisite courses before pursuing advanced study in the graduate program.

Minimum grade-point average for admission is 3.75 for the last sixty hours of

undergraduate study. Candidates with lower averages are considered on an individual basis if they possess significant experience in professional landscape architectural work before applying. Candidates from undergraduate design programs must accompany applications with samples of their design work.

To qualify for this degree, a student must complete a minimum of eight units distributed as follows: (1) three and one-half units totaled from Landscape Architecture 437, 477, 487, and 499; (2) two units selected from Landscape Architecture 435, 436, 457, and 467, according to the chosen interest area; (3) two and one-half units of electives chosen from 300-or 400-level courses offered outside the department. Students are expected to follow one of the recommended interest area programs although approval may be obtained from the department chairman for a special program. Elective possibilities are extensive and many course and research projects are selected by the student. Accordingly, there is ample opportunity to tailor a program to meet individual needs.

To encourage scholarly interaction, students from other disciplines are encouraged to consider landscape architecture courses where consent of instructor is stated as a prerequisite.

GRADUATE FACULTY

Professors: W. G. Carnes (Chairman of Department), W. M. Keith.
Associate Professors: T. C. Hazlett, A. J. Rutledge.
Assistant Professor: D. L. Walker, Jr.

COURSES FOR GRADUATES

435. **Urban Design.** Design development of new or renewed urban areas and systems in collaboration with architecture and urban planning students. 2 units. Prerequisite: Passage of special design examination; credit or registration in Urban Planning 384.

436. **Advanced Landscape Design.** Comprehensive master planning and site design for large public, semipublic, and private properties. Special problems in collaboration with students from other disciplines are encouraged. 1 unit. Prerequisite: Passage of special design examination or consent of instructor.

437. **Regional Landscape Design.** Detailed investigation of landscape resources and characteristics of large geographical areas; determination of land use design proposals. 1 unit.

457. **Landscape Management.** Investigation of management theories, policies, and practices which influence landscape preservation and development, with emphasis on their cumulative effects upon natural processes and aesthetic qualities. 1 unit. Prerequisite: Consent of instructor.

467. **Landscape Architecture Professional Education.** Investigation and analysis of philosophies, concepts, structures, and techniques of professional landscape architecture educational programs. 1 unit.

477. **Development of Landscape Architectural Thought.** Exploratory study of times, traditions, and philosophies which have shaped past and present attitudes toward landscape development; application to contemporary issues. ½ unit. Prerequisite: Consent of instructor.

487. **Seminar.** Preparation, presentation, and discussion of research papers on current and future areas of landscape architectural application. ½ unit. Prerequisite: Consent of instructor.

490. **Special Problems.** For students from disciplines other than landscape architecture. Individual projects and research in collaboration with landscape architec-

ture students. Opportunity for interaction among those whose disciplines are concerned with the development, use, and effects of the physical environment. Nature and scope of problems determined in consultation between student and faculty adviser. ½ to 1 unit. Prerequisite: Consent of instructor.

499. Thesis Research. 0 to 1½ units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

337. Advanced Landscape Design, I. Advanced problems of landscape design for urban and institutional situations. 1 to 1½ units. Prerequisite: Landscape Architecture 236.

338. Advanced Landscape Design, II. Terminal project; comprehensive landscape architectural development. 1 to 2 units. Prerequisite: Landscape Architecture 337.

LATIN-AMERICAN STUDIES

Graduate minors in Latin-American studies are administered by the Director of the Center for Latin-American Studies.

Candidates for the master's degree who elect a minor in Latin-American studies must complete two units from the courses prescribed by the Center for Latin-American Studies. Doctoral candidates who elect a minor in this area must complete four units for a sole minor, or two units for a split minor. Courses must be taken in at least two departments; lists of courses fulfilling the minor are available from the Center.

Students in technical and professional colleges and schools of the University who seek knowledge of Latin-American affairs, culture, and languages are invited to consult with the Director of the Center for Latin-American Studies, 1208 West California Avenue, Urbana, or with their advisers, in order to develop programs suited to their individual needs. Such a program may often be adopted as a special minor under existing regulations if the student so desires. These courses are of particular value to students who intend to carry on technical or professional work in the Latin-American area for the government, private business, publications, or religious organizations.

LAW

The College of Law offers a program of graduate work leading to the Master of Laws (L.L.M.), Master of Comparative Law (M.C.L.), and Doctor of the Science of Law (J.S.D.).

A student whose undergraduate study in law has been in systems based on the Anglo-American common law is eligible to apply for candidacy for the Master of Laws or Doctor of the Science of Law. A foreign lawyer whose prior law study has been in a system which is not based on the Anglo-American common law may, in exceptional cases, be admitted to candidacy for the Master of Laws or Doctor of the Science of Law, or such foreign lawyer may apply for candidacy for the Master of Comparative Law. The Master of Comparative Law program is designed to develop facility in the comparative method and to prepare a foreign lawyer to deal knowledgeably with Anglo-American problems.

For admission, an applicant must have received a first degree in law from a law school which has graduation requirements substantially the same as the University of Illinois College of Law, and must present evidence of ability to do satisfactory work at the graduate level. Normally no student is admitted as a candidate for the

Master of Laws unless he has a grade-point average of 4.0 in all law work previously undertaken. A student who is a candidate for the degree of Doctor of the Science of Law is normally required to have a grade-point average of 4.0 in all law work previously undertaken, and also to present evidence that he has the ability to do independent research; the latter requirement may be met by the submission of satisfactory legal writing done while the applicant was a candidate for the Doctor of Law (or equivalent degree), or subsequent to the receipt of that degree.

One academic year in residence is required of a candidate for an advanced degree. The programs consist of course work and research which have been approved by the committee on graduate study of the College of Law, comprising at least eight units of graduate work of which at least two for the master's degree and four for the doctor's degree must be in research. In addition to the course work and research, a thesis is required. For the master's degree, the thesis may be completed during the year in residence. For the doctor's degree, the thesis must be submitted not less than one year nor more than five years after the completion of the residence requirements, and the candidate must pass an oral examination before a committee of the faculty. The candidate for the Master of Laws must secure an average of 3.5 in his graduate law courses; the candidate for the Doctor of the Science of Law, an average of 4.0.

Details of the programs may be obtained from the Dean of the College of Law, 209 Law Building.

GRADUATE FACULTY

Professors: J. E. Cribbet (Dean of College of Law), D. C. Baum, M. W. Benfield, C. H. Bowman, K. S. Carlston, R. G. Cohn, G. T. Frampton, S. B. Goldberg, P. H. Hay, H. D. Krause, W. R. LaFave, P. H. Marshall, J. O'Connell, S. J. Plager, C. W. Quick, R. Reisner, H. Semmel, V. J. Stone, J. N. Young.

Associate Professors: M. P. Dooley, B. S. DuVal, Jr., R. W. Findley, P. B. Maggs, J. H. McCord, L. W. Waggoner.

Assistant Professor: E. J. Kionka.

COURSES FOR GRADUATES

400. Seminar: Legal Education. Problems in legal education, curricula, teaching materials, methods of teaching, the place and function of individual courses in the law school program. ½ unit.

499. Thesis Research. ½ to 3 units.

PROFESSIONAL COURSES

301. Contracts A. Offer and acceptance, consideration, seals, Statute of Frauds. 1 unit (for recommended M.C.L. candidates only). Benfield, Hay, Maggs.

302. Contracts B. Third-party beneficiaries, assignment, conditions, impossibility, anticipatory repudiation, and discharge; contract and quasi-contract distinguished, and measure of damages for each. 1 unit (for recommended M.C.L. candidates only). Prerequisite: Law 301. Benfield, Hay, Maggs.

303. Torts A. Basic course in civil wrongs, including intentional infliction of emotional harm, right of privacy, libel and slander, and unfair commercial practices. ½ unit (for recommended M.C.L. candidates only). Krause, O'Connell, Quick.

304. Torts B. Basic course in civil wrongs, including negligence, liability without fault, tort liability of owners and occupiers of land, and the impact of

insurance on tort liability. 1 unit (for recommended M.C.L. candidates only). Prerequisite: Law 303. KRAUSE, O'CONNELL, QUICK.

305. Judicial Remedies. Introduction to civil procedure, common-law forms of action, extraordinary legal remedies, nature of equity jurisprudence, equitable remedies, abolition of the forms of action, fusion of law and equity, statutory remedies. 1 unit (for recommended M.C.L. candidates only). MARSHALL, SEMMEL, STONE.

307. Property A. The concept of property; acquisition of private property; recognized property interest (personal, real, estates in land). 1 unit (for recommended M.C.L candidates only). CRIBBET, FINDLEY, PLAGER.

308. Property B. Gratuitous transfer of property interests; commercial transfers (sale, lease); the use of property. 1 unit (for recommended M.C.L. candidates only). Prerequisite: Law 307. CRIBBET, FINDLEY, PLAGER.

309. Criminal Law. The sources and purposes of the criminal law; the meaning of criminal responsibility; the characteristics of particular crimes. 1 unit (for recommended M.C.L. candidates only). BOWMAN, LAFAVE.

310. Constitutional Law. The apportionment of governmental power between the United States and the states, and the limitations on power resulting from the contract, equal protection, and due process clauses. 1 unit (for recommended M.C.L. candidates only). DUVAL, GOLDBERG, REISNER.

320. Business Associations. The fundamental legal consequences to principals, agents, and third parties of association in various types of business transactions and in various forms of business enterprise. 1 unit (for recommended M.C.L. candidates only). BAUM, FRAMPTON.

322. Commercial Law, I. A study of the major problems involved in the exchange of goods and commercial paper with special emphasis upon the history and interpretation of the Uniform Commercial Code as it affects commercial transactions. 1 unit. BENFIELD, DOOLEY.

323. Administrative Law. The functions of administrative tribunals in federal, state, and municipal government, the procedure before such administrative tribunals, and judicial relief from administrative decisions. 1 unit. COHN.

324. Corporations. Promotion and organization of corporations and the rights and liabilities of officers, directors, and shareholders. 1 unit. BAUM, FRAMPTON, MCCORD.

326. Evidence. Principles governing the competency of witnesses and the admissibility of evidence. 1 unit. MARSHALL, QUICK.

328. Income Taxation. A study of federal income tax problems relating to business and investment transactions. Subjects treated include the concept of taxable income; allowable deductions; accounting for income and deductions; capital gains; partnership operations; corporate distributions and organizations; and tax procedure. 1 unit. MCCORD, YOUNG.

329. Decedents' Estates and Trusts. A study of the gratuitous disposition of property by intestacy, by will, and by inter vivos gifts and trusts, including administration of decedents' estates and trusts. 1 unit. KIONKA, WAGGONER.

330. Restitution. Contractual and quasi-contractual remedies (both legal and equitable) available because of duress, fraud, innocent misrepresentation, mistake, illegality, and economic compulsion in the formation and discharge of contracts and other transactions. 1 unit. DUVAL.

331. Legislation. A study of legislative policies and procedures, of legislation as a

source of law, of types of statutes and their structure, and of the problems of interpretation. 1 unit. COHN.

333. **Persons.** Creation and dissolution of the family unit and relations between members thereof; marriage, separation, divorce, rights and duties of spouses and means for their enforcement; legal capacity of wife and infant. ½ unit. KRAUSE.

334. **Criminal Law Administration and Procedure.** Problems in the administration of the criminal law; a study of criminal procedure from arrest to the end of the prosecution in a court of review, with emphasis on procedure as a device for social regulation, and including an appraisal of aims and workings of probation, parole, and executive clemency. ½ unit. BOWMAN, LAFAVE.

335. **Trials and Appeals.** Ligation from process through appeal, excluding pleading and evidence. 1 unit. MARSHALL, SEMMEL, STONE.

337. **Commercial Law, II.** Selected problems under the Uniform Commercial Code in modern commercial banking law and practice. ½ unit. BENFIELD.

338. **Insurance.** Personal and property insurance; formation of the insurance relation; concealment, warranties, representations; insurable interest; conditions; subrogation; waiver and estoppel; incontestability; the respective interests of the beneficiary, insured, insurer, asignee, and creditor, and facts constituting maturity in life, accident, fire, theft, liability, and collision policies. ½ unit. DOOLEY.

339. **Conflict of Laws.** Problems from conflict of laws involving jurisdiction of courts; judgments; torts and workmen's compensation; contracts; property; family law; administration of estates; business organizations; governmental activities. 1 unit. DUVAL, HAY.

340. **Local Government Law.** History and functions; judicial, legislative, and administrative control; creation, dissolution, and changes in structure; law-making powers; finance; planning and development functions; regulatory powers; contracts; tort liabilities; federal-local and inter-local relations. 1 unit. BAUM.

341. **Oil and Gas.** Nature of the property interests in oil and gas; legal interests created by oil and gas leases; validity of leases; the habendum clause; the drilling and rental clauses; transfer of oil and gas interests; rents and royalties; public regulation of the production of oil and gas. 1 unit. FINDLEY.

342. **Mortgages.** A study of real estate mortgages. 1 unit. FINDLEY.

343. **Admiralty.** Admiralty and maritime jurisdiction; the maritime lien; carriage of goods; salvage; general average; collision; claims of seamen; limitation of liability; application of state law; sovereign responsibility; choice of law. 1 unit.

344. **Creditors' Rights.** Remedies of the delinquent debtor and his creditors under the Bankruptcy Act; liquidation and rehabilitation; exercises in bankruptcy procedures. 1 unit. BOWMAN.

345. **Civil and Political Rights.** A study of some of the basic problems in the relation of the individual to government and in the protection of rights of minority groups. ½ unit. REISNER.

346. **Future Interests.** A study of the validity and effect of gratuitous dispositions of assets in which enjoyment is postponed, restrained, or long continued; classification of future interests; construction; powers of appointment; rule against perpetuities and related restrictions. 1 unit. WAGGONER.

347. **Labor Law, I.** Same as Labor and Industrial Relations 347. The law of industrial relations with special emphasis on recent cases and legislation; the

establishment of the collective bargaining relationship; strikes, boycotts, and picketing; Federalism and labor relations. 1 unit. GOLDBERG.

348. International Law. The nature, sources, and subjects of international law, its place in the control of international society, and an examination of the law of jurisdiction, territory, recognition, and succession of states, rights and immunities of states in foreign courts, diplomatic immunities, treaties, protection of citizens abroad, settlement of international disputes, war and neutrality, the United Nations, and the International Court of Justice. 1 unit. CARLSTON.

349. State and Local Taxation. Proper and improper purposes of taxation; the general property tax and its administration; taxpayers' remedies; excise taxes on business concerns and transactions; problems of jurisdiction to tax. ½ unit. YOUNG.

351. Jurisprudence. The place of law in society, the goals and methods of law, the nature of law, relation of law and social science. 1 unit. CARLSTON.

352. Taxation of Gratuitous Transfers. Various tax problems encountered in the distribution of wealth by inter vivos and testamentary disposition, including a study of federal estate and gift taxes, the Illinois inheritance tax, problems in the assignment of income, and federal income taxes upon estates and trusts. Attention is given to tax planning in the distribution of wealth. ½ unit. KIONKA, MCCORD, YOUNG.

353. Corporation Finance and Securities. Drafting provisions of preferred shares; counseling problems requiring written memoranda on the application of state and federal securities laws to the marketing of securities and on the effect of statutes and decisions on distribution of dividends, redemption and purchase of shares, and recapitalization, reorganization, and dissolution of corporations. ½ unit. FRAMPTON, MCCORD.

355. Trade Regulation. Antitrust law, control of restrictive business practices, monopoly, unfair competition, trademarks, price discrimination, resale price maintenance, Federal Trade Commission. 1 unit. CARLSTON.

356. Federal Courts. The federal judicial system; relationship of federal and state law; jurisdiction of federal courts and their relation to state tribunals. 1 unit. STONE.

358. Modern Social Legislation. A focus, for illustrative purposes, on the traffic victim and his claim for compensation: the present common-law method compared with various schemes of social insurance; problems of coordinating, as well as comparing, any such scheme of social legislation with the tort system and with other social and private insurance arrangements such as workmen's compensation, Blue Cross, etc. Attention is given to both broad questions of social policy and technical drafting problems. 1 unit. O'CONNELL.

359. Legal History. The development of the common-law system in England and America: the origin and growth of English legal thought, legal doctrine, and legal institutions; the history of real property, contracts, and torts; the origin and development of courts, legislation, equity, the doctrine of precedent; the evolution of the legal profession; the reception of the common law in America. 1 unit.

365. Tax Problems. Selected problems relating to partners and partnerships, corporations and shareholders. ½ unit. MCCORD, YOUNG.

369. Soviet Law. An examination of Soviet conceptions of the role of law as evidenced both in theory and in practice; emphasis on highlights of Soviet law, with comparison to the common-law and civil-law traditions; study of Soviet court and legislative materials to determine characteristic pattern with respect

to: constitution and administration, the relation of the individual with the state and with society; legal regulation of property and productive institutions, private relationships, and international law. 1 unit. MAGGS.

370. **Labor Law, II.** Advanced problems in the law of industrial relations with particular emphasis on the negotiation and administration of the collective bargaining agreement; the relation between the individual and the union. ½ unit. Prerequisite: Law 347 or consent of instructor. GOLDBERG.

371. **Seminar in Selected Legal Problems.** An introduction to the methods and materials of legal research. The work of the course consists of the discussion of selected topics. In addition, each student investigates a topic approved by the instructor. The results of the investigation are presented orally to the class and submitted in writing to the instructor. The several sections are oriented to different subject matter areas. Credit may be earned in more than one section. ½ unit.

372. **Problems in Estate Planning.** Selected problems in the planning of estates which serve to integrate the basic materials in property, trusts, wills, income, estate, and gift taxation. ½ unit. MCCORD, YOUNG.

382. **Comparative Law.** A comparative analysis of the three basic institutions of private law: tort, contract, and property. The solutions arrived at in the common-law system are contrasted with the solutions arrived at in the civil-law system and in the Soviet legal system. 1 unit. KRAUSE.

383. **Law and Society.** An examination of some important ideas concerning the nature of law and the role of law in society. 1 unit. REISNER.

387. **International Economic Organizations.** A survey of the principal international economic organizations such as GATT, OECD, ECE, and international monetary and investment institutions (IMF, IBRD, AID) ; an intensive study of the European Common Market, particularly of its laws relating to trade barriers, establishment of companies, and antitrust; United States legislation in the field of international trade (Trade Expansion Act of 1962) . 1 unit. HAY.

399. **Research in Special Topics.** Individual research on a special problem selected in consultation with the instructor. ½ or 1 unit.

LIBRARY SCIENCE

The purpose of the Graduate School of Library Science is to prepare young men and women for careers as professional librarians in all types of libraries. Programs of study may be followed leading to the master's degree, Certificate of Advanced Study in Librarianship, and doctor's degree in library science.

Master of Science. Applicants for admission to the Graduate School of Library Science must first be admitted to the Graduate College.

In addition to the Graduate College requirements, applicants to the Graduate School of Library Science must meet the following requirements: (1) a minimum grade-point average of 3.75 for the last sixty hours of academic work completed; (2) one sequence (two terms) of courses at the college level in each of the three main fields of science, social science, and humanities, and a total of four such sequences in all; (3) a major subject in any field of study, comparable to the undergraduate major at the University of Illinois (at least twenty-four semester hours) ; (4) two years of college-level study of any foreign language. This may be either two years of study of one language or one year of each of two languages.

A candidate for the master's degree must complete a prescribed program of undergraduate courses. This requirement may be met by one of the following: (1)

completion of a minimum of sixteen semester hours of library science with a grade-point average of at least 4.0 in an institution approved by the Graduate School of Library Science; (2) completion of the preparatory sequence of four courses, Library Science 201, 204, 255, and 258, in the Graduate School of Library Science with a grade-point average of at least 4.0. Exemption from one or more of these courses may be secured by a satisfactory score on a comprehensive examination which is offered on the day preceding the opening of registration each semester and summer session. There is a special offering of these four courses each eight-week summer session, enabling beginning students to complete the entire preparatory sequence before taking regular graduate library science courses in the fall semester. This makes possible the most efficient and satisfactory program, and students are urged to plan accordingly.

At least two semesters in residence—or the equivalent—are required to earn the master's degree, in addition to attendance in preparatory courses. In this period, eight units of graduate study should be completed. Each student's program of study, adapted to his particular needs and purposes, is planned in consultation with an adviser at the time of original registration and thereafter. Students who have completed their undergraduate library science requirement in institutions other than the University of Illinois are required to take the comprehensive examination and to complete Library Science 405, 407, and 411 or 412, and one of the 300-level literature courses. No thesis is required.

Students interested in the Advanced Master's program, the Certificate of Advanced Study in Librarianship, and the Doctor of Philosophy degree should write to the Director of the Graduate School of Library Science, 329 Library. Other supplementary material is also available from this source.

GRADUATE FACULTY

Professors: R. B. Downs (Dean of Library Administration), H. Goldhor (Director of the Graduate School of Library Science), Frances B. Jenkins, Winifred C. Ladley, M. Alice Lohrer, R. E. Stevens.
Assistant Professors: W. C. Allen, Kathryn L. Henderson, Cora E. Thomassen.

COURSES FOR GRADUATES

402. Studies in Reading. Designed to acquaint students with the major areas of investigation and interest in reading. Special attention is given to studies of reading interests and habits of children, youth, and adults. Class discussions are devoted to analysis of various studies and their implications for library service and classroom teaching. 1 unit. Ladley, Lohrer.

405. Library Administration. Designed to supply knowledge of the internal organization of libraries and of the principles of library administration. Emphasis is on comparison of the conditions found in the several kinds of libraries and on applications of the general theory of administration. 1 unit. Prerequisite: Library Science 204 or consent of instructor. Field.

406. Library Service to Children and Young Adults. The role, problems, and needs of library service in the elementary and secondary school fields, and of library work with children and young adults in the public library. 1 unit. Credit is not given for Library Science 406 in addition to credit in Library Science 307. Prerequisite: Library Science 204 or 405. Ladley, Lohrer.

407. Cataloging and Classification, I. The theory, practice, and application of the principles of cataloging and classification. Emphasizes subject cataloging and complex types of entry. Problems provide experience with the Decimal Classification and Library of Congress Classification and Library of Congress subject

headings. 1 unit. Prerequisite: Library Science 255 or consent of instructor. HENDERSON.

408. Cataloging and Classification, II. The theory, practice, and application of the principles of cataloging and classification. Takes up the cataloging and classification of special types of materials, including maps, music, films, slides, phonograph records, and incunabula and other rare items. Includes some discussion of the administrative problems of a cataloging department. 1 unit. Prerequisite: Library Science 407. HENDERSON.

409. Communication Roles and Responsibilities of Libraries. Mass media of communication are considered in terms of their relations with modern library services; media organization, content, and research are reviewed; problems of intellectual freedom are considered as an aspect of communications behavior; and the potential role of electronic devices in library activities now and for the future is discussed. 1 unit.

410. Adult Education and Libraries. The literature, history, and problems of adult education in the United States are presented in relation to the role of the library as an educational agency. Students study organization for adult education in the community and become familiar with the significant methods and materials used in a variety of educational programs. 1 unit.

411. Reference Service in the Humanities and Social Sciences. Detailed consideration of the bibliographical and reference materials in various subject fields, with training and practice in their use for solving questions arising in reference service. 1 unit. Prerequisite: Library Science 201 or consent of instructor. ALLEN, STEVENS.

412. Science Reference Service. Study of representative reference sources in pure and applied science. Designed to acquaint the student with typical problems encountered in providing and servicing scientific reference materials. 1 unit. Prerequisite: Library Science 201 or consent of instructor. JENKINS.

415. Library Mechanization and Automation. Introduces various types of equipment for handling information and providing services in libraries; studies applications to library operations; includes introduction to systems planning, to automation concepts, and to computer use. 1 unit. Prerequisite: Library Science 201, 204, 255, and 258, or consent of instructor.

424. Government Publications. The nature and scope of American and British government publications; the problems of organization arising from their form and from the methods of their production and distribution. 1 unit. Prerequisite: Library Science 411 or 412, or consent of instructor. FIELD.

427. Resources of American Research Libraries. Aims to acquaint students with the distribution and extent of American library resources for advanced study and research; spatial and financial aspects of library resources; methods of surveying library facilities; growth and use of union catalogs and bibliographical centers; interinstitutional agreements for specialization of collections and other forms of library cooperation; and ways and means of developing research collections in special subject fields. 1 unit. STEVENS.

428. Library Buildings. A study of the library's physical plant in the light of changing concepts and patterns of library service. Present-day library buildings, both new and remodeled, are analyzed and compared with each other as well as with buildings of the past. The interrelationship of staff, collections, users, and physical plant is examined in detail. Class discussion is supplemented by visits to new libraries and conference with their staffs. 1 unit. Prerequisite: Library Science 405 or consent of instructor.

429. Information Storage and Retrieval. Analyzes the problems which confront libraries and library users as a result of the growth of literature; reviews the various systems for storing and retrieving information; introduces the underlying models and basic types of equipment for both traditional and non-conventional systems; emphasizes practical applications in libraries. 1 unit. Prerequisite: Library Science 415; consent of instructor.

430. Advanced Reference. Designed to enable the student to utilize the varied resources of a large research library. Deals with the method of analyzing and solving bibliographic problems such as arise in scholarly libraries and in connection with research projects. 1 unit. Prerequisite: Library Science 424 or consent of instructor. ALLEN.

431. Books and Libraries in the Ancient and Medieval World. The development of writing and of the book in ancient and medieval times; book collecting and the growth of libraries from earliest times to the discovery of printing. 1 unit. STEVENS.

432. Books and Libraries Since the Renaissance. Same as Communications 432. The development of printing since the fifteenth century, and its effect on the nature and use of the book; the growth of national, college and university, public, and other libraries in Europe and America from the Renaissance to the present day. 1 unit. STEVENS.

433. Advanced Subject Bibliography. A study of the literature, information sources, and reference aids in various specialized fields of knowledge, identified as different sections of this course, from the point of view of their use by librarians. No student may take more than two different sections for credit toward a degree: (b) biological sciences, (c) chemistry, (d) education and psychology, (e) engineering, (g) law, (h) maps, (i) music, (j) mathematics, (k) Slavic bibliography. ½ unit. Prerequisite: Consent of instructor. STAFF.

434. Library Systems. Considers the development of library systems, with special reference to public libraries as a norm for the development of library services: library standards, the growth and development of county and regional libraries, the role of the state library and of federal legislation are among the topics treated in detail. 1 unit. Prerequisite: Library Science 405 or consent of instructor.

436. Development of the Library Catalog. The history and philosophy of classification schemes and cataloging codes, and comparative study of present-day cataloging practices. 1 unit. Prerequisite: Library Science 407, 408, or consent of instructor.

438. Administration and Use of Archival Materials. Administration of archives and historical manuscripts, with emphasis on the processing and research use of archival materials. 1 unit. Prerequisite: Consent of instructor. BRICHFORD.

439. Medical Literature and Reference Work. Considers representative reference and bibliographical aids in medical sciences. Problems provide experience with typical medical reference sources (only at the University of Illinois Medical Center in Chicago) . S; 1 unit. Prerequisite: Consent of instructor.

440. Problems in Bibliographical Method. Same as English 450. Work on individual bibliographical problems, with a study of bookmaking, manuscripts and their relation to the printed text, editorial problems, and literary forgeries. 1 unit. Prerequisite: Consent of instructor.

441. History of Children's Literature. Interpretation of children's literature from the earliest times to the present, with recognition given to the impact of the changing social and cultural patterns on books for children and on children's

reading. Attention is given to the early printers and publishers of children's books and to magazines for children in the nineteenth century. 1 unit. LOHRER.

442. Seminar in Library Materials for Children and Young Adults. Advanced study of the criteria for the evaluation of books, films, and recordings. Each student completes a project on a given theme or subject, involving extensive and critical reading, viewing, and listening. 1 unit. Prerequisite: Library Science 303 or 304, and Educational Psychology 211, or consent of instructor. LADLEY.

443. Contemporary Book Publishing. Survey of twentieth-century book publishing, particularly in America, placing it in an economic, social, and literary context. Emphasis is on production, technological developments, economic structure, methods of distribution and promotion, and book publishing as an art. 1 unit.

COURSES FOR ADVANCED GRADUATES

450. Advanced Studies in Librarianship. Directed and supervised investigation of selected problems in library resources, reference service, research libraries, reading, public libraries, or school libraries. ½ to 2 units. Prerequisite: Fifth-year degree in library science or consent of director. STAFF.

462. History of Education for Librarianship. A study of the origin and development of library science education in this country and abroad; emphasis is placed on the major events and activities which led to the present status of library school programs. 1 unit. Prerequisite: Master of Science in Library Science or consent of instructor.

463. Current Developments in Technical Services. An examination of changing policies and procedures in the administration of acquisitions, cataloging, binding, photographic reproduction, and related areas. 1 unit. Prerequisite: Master of Science in Library Science or consent of instructor. STEVENS.

465. Librarianship and Society. Analysis of the role and functions of libraries in the twentieth century; the changing characteristics of information and knowledge are viewed as major determinants of libraries' relations to society. 1 unit. Prerequisite: Master of Science in Library Science or consent of instructor.

468. Teaching Methods and Special Problems in Contemporary Library Schools. Designed for those interested in preparing for the teaching of library science at the graduate level. Current library school programs and the various methods of instruction are analyzed as to effectiveness and application for the major areas of library science content; attention is given to the process of curriculum construction to meet the changing needs of the profession and to the experience of other professions. 1 unit. Prerequisite: Library Science 462 or consent of instructor. GOLDHOR.

469. Principles of Research Methods. Designed for persons planning to engage in research. The course reviews significant investigations in the library field, and considers the use of hypotheses, the conduct of experiments, the nature of proof, and the employment of statistical methods, with a view to helping students develop their dissertations. Required for doctoral candidates. 1 unit. Prerequisite: Knowledge of the principles of statistics, Master of Science in Library Science, or consent of instructor. GOLDHOR.

499. Thesis Research. Individual study and research. Section A: M.S. candidates, 0 to 2 units. Section B: Ph.D. candidates, 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Literature of the Humanities and Social Sciences. This course is designed to build a knowledge of the scope and significant characteristics of the several

fields comprising the humanities and social sciences through a systematic study of names, trends, and outstanding classic and current materials in each. Attempts to identify general basic knowledge for each field which is essential for the librarian in selection of materials and reading guidance. 1 unit.

302. Literature of the Sciences. An introduction to the scope and significant characteristics of the literature of science, to modern concepts and representative literary works in each of the major fields of pure and applied science. Designed to give an insight into the content of the scientific disciplines and of their role in modern society. Selected readings and films acquaint students with representative material in the field. 1 unit. Prerequisite: Library Science 204, 258, or consent of instructor. JENKINS.

303. Library Materials for Children. The selection and use of library materials for children in public and school libraries, according to the needs of the child in his physical, mental, social, and emotional development and the purposes of the elementary school program. The student becomes acquainted with the standard selection aids for children and with all types of printed and audio-visual materials, and develops the ability to select and describe children's library materials according to their developmental uses. Credit is not given for Library Science 303 in addition to credit in Library Science 307. ½ or 1 unit. LADLEY, LOHRER, THOMASSEN.

304. Library Materials for Young Adults. The selection and use of library materials for the young adult in school and public libraries and community organizations. The course aims to develop the ability to select and evaluate a wide variety of reading materials from standard bibliographies for the adolescent according to his personal and school needs. Credit is not given for Library Science 304 in addition to credit in Library Science 307. ½ to 1 unit. LOHRER, THOMASSEN.

307. Library Materials and Services for Children and Young Adults. A nonspecialist's view of the materials and services involved in work with children and young adults, including a brief survey of print and nonprint materials for children and young people, and basic guidelines for library services to them. Credit is not given for Library Science 307 in addition to credit in Library Science 303, 304, 309, or 406. 1 unit. Prerequisite: Consent of instructor.

308. Audio-Visual Services in Libraries. Designed to acquaint students with the typical audio-visual programs and responsibilities of libraries. Group activities stress, through presentation and evaluation, the use of materials and related equipment necessary for film, radio and television, exhibit and other programs of libraries. The practices of audio-visual departments in libraries are reviewed and evaluated. 1 unit. THOMASSEN.

309. Storytelling. Fundamental principles of the art of storytelling including techniques of adaptation and presentation for children of various ages. Content and sources of materials; story cycles; methods of learning; practice in storytelling; planning the story hour for the school and public libraries, for recreational centers, for the radio, and for television. Open to undergraduates and non-Graduate School of Library Science students. Credit is not given for Library Science 309 in addition to credit in Library Science 307. ½ or 1 unit. LADLEY.

310. Typographic Disciplines of the Book. Same as Journalism 310 and English 392. The study of the book as a manufactured object, with emphasis upon practices and methods in continuous use from the Renaissance to the present, including type faces, paper, binding, and illustration. Extensive practicum in the typographic laboratory. ½ unit. Prerequisite: Consent of instructor.

354. Audio-Visual Communication. Same as Elementary Education and Secondary and Continuing Education 354. An analysis and application of those introduc-

tory aspects of communication theory and practices concerned with the design and use of audio-visual messages which influence the learning process. This course is also concerned with selection, utilization, production, and evaluation of audio-visual materials and selected technological aids. ½ or 1 unit. Prerequisite: Senior or graduate standing.

LIFE SCIENCES

(Including Biology, Botany, Entomology, Microbiology, Physiology and Biophysics, and Zoology)

The School of Life Sciences is a unit of the College of Liberal Arts and Sciences and includes the departments of Botany, Entomology, Microbiology, Physiology and Biophysics, and Zoology. Study programs leading to the graduate degrees of Master of Science and Doctor of Philosophy exist in each of the departments and are described in detail in the following pages. Interdepartmental study programs leading to advanced degrees in cell biology and virology, and plant physiology are administered within the School. The School also participates with other departments of the University in offering the Ph.D. program in genetics (see page 218) and with the Department of Chemistry and Chemical Engineering in offering a program in biophysical chemistry (see page 119). Applicants who desire to enter any of the graduate study programs are usually required to have earned a grade-point average of at least 4.0 for their last sixty hours of undergraduate work. In certain programs, applicants with a grade-point average between 3.5 and 4.0 are considered by a special committee.

Support for graduate training is available in the form of teaching or research assistantships, University fellowships, or trainee fellowships. Prospective students may obtain application forms and relevant information for departmental study programs from the executive officer of the appropriate department, or for interdepartmental study programs from the Director of the School of Life Sciences.

INTERDEPARTMENTAL STUDY PROGRAMS

Master of Science in the Teaching of the Biological Sciences and General Science. This degree is offered with the completion of the fifth year in the teacher-education curriculum in biological and general science. The degree is primarily intended for but not restricted to certified teachers of biology and general science in junior high school, high school, and junior college. For admission to this degree program, students must have a grade-point average of at least 3.5. See pages 38 and 39.

Candidates for the Master of Science in the Teaching of the Biological Sciences and General Science must earn four units in biological sciences, two units in education, and two units in electives. The two units in education must include: History and Philosophy of Education 304 and 305, one unit; and Educational Psychology 311 and 312, one unit. Electives may be in the biological sciences, in education, or, in exceptional cases, in other fields. A course in biological chemistry is strongly advised. The adviser for candidates for this degree is Professor Joseph Larsen, 318c Morrill Hall.

Master of Science in Biology. The program of study leading to the master's degree in biology is designed for individuals who (1) wish additional training at the master's level for professional proficiency in teaching or research, (2) desire to continue to the Ph.D. degree, possibly in one of the programs sponsored by the School of Life Sciences, or (3) do not wish to limit their training to a single area of biology. Students whose interests fall into a specific area of biology should apply directly to the relevant department or program.

Admission to this curriculum requires a grade-point average of 4.0 or higher.

Applicants whose grade-point average is less than 4.0 but 3.75 or higher will be considered on an individual basis. Those in the latter group should outline their educational objectives in a three hundred-word essay and should, in addition, submit three letters of recommendation. Although no specific undergraduate courses are required for admission to this curriculum, a year of physics, a course in organic chemistry, and a semester of calculus or statistics must be completed before a degree is granted. Preference is given to those applicants who have already completed most of these courses.

Candidates for the degree are advised to obtain a broad, basic training in biology and are examined in aspects of cellular, organismic, and population biology. Of the eight units required for the degree, at least two units must be taken in 400-level courses. A thesis is not required, but at least one unit of individual problem work must be included. A comprehensive examination is required of all candidates for the degree. Students who are preparing themselves for high school teaching and who are not yet certified must fulfill state certification requirements.

Doctor of Philosophy in Biology. The School of Life Sciences offers Ph.D. programs in several interdepartmental areas, cell biology and virology, and plant physiology. Entrance requirements, in addition to those listed on page 267 for the M.S. program, include background training in general biology, physics, biochemistry, and calculus, but deficiencies in these areas may be remedied during the first year of graduate study. Study programs are designed to suit individual needs in consultation with advisers. Descriptions of the area programs are given below.

Students who have been accepted for one of these programs may select any faculty member in the School of Life Sciences, or an appropriate member of the Biochemistry Division as a major adviser. Additional information may be obtained from the Director of the School of Life Sciences.

CELL BIOLOGY AND VIROLOGY

The cell biology and virology program emphasizes molecular mechanisms and is therefore addressed to students who have acquired or wish to acquire a strong background in chemistry. Areas of research open to students in this program include cytochemistry, biochemistry of subcellular systems, cellular differentiation, intercellular regulation of meiosis and mitosis, circadian rhythms, cellular genetics, and viology.

GENETICS

See page 218.

NEUROSCIENCES

The program in neurosciences is interdepartmental, and its staff includes psychologists, physiologists, biochemists, and ethologists. Required courses are in physiological psychology, animal behavior, biochemistry, physiology of axons, synapses and higher nervous systems. Research areas include neurochemistry, ethology, cybernetics, comparative and mammalian neurophysiology, neuroanatomy, and physiological psychology.

PLANT PHYSIOLOGY

Plant physiology is an interdepartmental area of specialization coordinated under the biology program. The program is staffed by plant physiologists from the five plant science departments (Agronomy, Botany, Forestry, Horticulture, and Plant Pathology). Thesis research can be conducted in any of these departments. Areas of research include photosynthesis, respiration, membrane transport, nitrogen

herbicide action, water relations, and environmental physiology. In addition to plant physiology, students are required to complete courses in biochemistry and physical chemistry.

Biology

The following courses are administered directly by the School of Life Sciences. These courses, as is the case with departmental courses, are applicable to the study programs within the School.

COURSES FOR GRADUATES

405. Methods of Taxonomy. A survey of basic procedure and techniques utilized in zoological classification. Major topics are assembly and arrangement of zoological materials, use of the fundamental taxonomic literature, descriptive and inferential statistical methods, data processing, and the interpretation and presentation of results and investigations. ¾ unit. Prerequisite: Biology 305 or equivalent; a course in statistics.

409. History of Biology. The development of biological concepts from the classical Greek period to the present. 1 unit. Prerequisite: Consent of instructor. HEATH.

411. Discussions in Genetics and Cytogenetics. ¼ unit.

418. Concepts and Topics in Immunology. Same as Veterinary Medical Science 418. Newer concepts and theories in the field of immunology, including theories of antibody formation and immunologic tolerance, regulation of the immune response, biosynthesis and structure of antibodies, and evolutionary aspects of the immune response. Lectures and discussion. ½ unit. Prerequisite: Consent of instructor. Microbiology 327 and Biology 307 recommended. SEGRE.

423. Electron Microscopy. Same as Chemistry 423. Lectures, discussions, and demonstrations on the physical principles and electron optics of the transmission electron microscope and its modern variants, including lectures and demonstrations of modern high vacuum techniques. Open to qualified graduate students in all departments. ½ unit. Prerequisite: A course in modern physics or physical chemistry (having calculus as a prerequisite) affording an introduction to wave mechanics, or consent of instructor. HALL.

429. Electron Microscopy with Laboratory. Same as Chemistry 429. General lectures on theory and design of electron microscopes without mathematical derivations; discussion and practice on specimen preparation; operation of electron microscopes with separate sections to meet special needs of biologists, geologists, and those interested in electron diffraction. Most theory lectures may be omitted by those enrolled or having credit in Biology or Chemistry 423. Open to qualified graduate students in all departments. 1 unit. Prerequisite: Two semesters of general physics, two semesters of college mathematics, and three semesters of chemistry; or consent of instructor. HALL.

430. Biological Ultrastructure. Lectures and reports on the fine structure of plant and animal cells and cell products with discussions of possible relationships of ultrastructure to function and of diverse interpretations of chemical-physical information as ultrastructure. 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Consent of instructor. HALL.

440. Advanced Plant Physiology, I. A comprehensive presentation of current knowledge in plant physiology. First semester of a two-semester sequence covering cell organization and function, respiratory and photosynthetic mechanisms, transport processes, nutrition, biosynthesis, growth, development and reproduc-

tion. 1 unit. Prerequisite: Chemistry 350 and 355; Botany 330 and 335; or consent of instructor. HANSON.

441. Advanced Plant Physiology, II. A comprehensive presentation of current knowledge in plant physiology. Second semester of a two-semester sequence covering cell organization and function, respiratory and photosynthetic mechanisms, transport processes, nutrition, biosynthesis, growth, development and reproduction. 1 unit. Prerequisite: Biology 440. HANSON.

490. Special Topics in Biology. Individual topics in research and/or reading conducted under the supervision of faculty members in the School of Life Sciences. This course is particularly designed for students enrolled in the biology program who would like to become more familiar with specialized fields of study prior to committing themselves to a specific area for their doctorate degree. ½ to 2 units.

493. Advanced Electron Microscopy. Conferences and practice dealing with specialized laboratory techniques, preparation of specimens, and the analysis and study of varied materials by use of transmission and/or scanning electron microscopes, and by the techniques of electron diffraction. Open to qualified students in all departments. ¼ or ½ unit. Prerequisite: Biology or Chemistry 429; consent of instructor. HALL.

499. Thesis Research. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

305. Principles of Taxonomy. A discussion of the development and current status of the principles of taxonomy in general, together with a detailed consideration of the evolutionary processes producing animal taxa and the phylogenetic and statistical concepts pertinent to their classification. ¾ unit. Prerequisite: Biology 210 or equivalent. SELANDER.

307. Immunology. Introductory course in the fundamentals of immunology with emphasis on biological application; designed to give a basic background for understanding immunological responses with an introduction to techniques applicable to biological research. ¾ unit. Prerequisite: Four semesters of college biology; Chemistry 133 or 234 or consent of instructor. MACLEOD.

308. Experimental Immunobiology. An introduction to laboratory techniques employed in immunological investigations. Laboratory. ½ unit. Prerequisite: Credit or registration in Biology 307; consent of instructor. ALGER.

309. Population Biology Laboratory. A laboratory designed to complement and exemplify certain concepts in population ecology and genetics, ethology, community ecology, and biometrics as discussed in Biology 310-311. Laboratory experiments and field observations; one or two Saturday morning field trips. ½ unit. Prerequisite: Credit or registration in Biology 310, or consent of instructor. WILLSON.

310. Principles of Population Biology, I. The sequence Biology 310 and 311 provides an integrated treatment of population concepts in biology. Major topics covered include: ecology, ethology, population genetics, and evolution. ¾ unit. Prerequisite: Biology 210 or consent of instructor; college algebra. DAWSON, WILLSON.

311. Principles of Population Biology, II. Continuation of Biology 310. ¾ unit. Prerequisite: Biology 310 or consent of instructor. DAWSON.

351. Population Biology. A study of problems associated with the behavior of plant and animal populations based on genetic, evolutionary, and ecological princi-

ples. ¾ unit. Prerequisite: Biology 151 and 251, and/or consent of instructor. GHENT.

371. **Quantitative Biology.** Theory and practical application in biology of probability and statistics. Lectures and assigned problems. 1 unit. Prerequisite: College algebra; consent of instructor. GHENT.

DEPARTMENTAL STUDY PROGRAMS AND COURSES

Botany

The Department of Botany offers graduate work leading to the Master of Science and Doctor of Philosophy degrees. All applicants for admission are considered on an individual basis. It is desirable that applicants have had some undergraduate training in botany or biology and related sciences. Applicants should have a minimum grade-point average of 4.0 (on a 5.0 scale), but those with averages between 3.75 and 4.0 are also considered.

The following subjects comprise a partial listing of areas of specialization available within the department: anatomy, cytology, ecology, genetics, morphogenesis, mycology, paleobotany, photosynthesis, phycology, physiology, systematics, and virology. Students who work with members of the botany faculty may also choose from the interdepartmental degree programs, including cell biology and virology, biophysics, genetics, and plant physiology. Each of these areas has well-equipped facilities for graduate student research. The department's laboratories and growth chambers are in a new, air-conditioned building, with herbarium and greenhouses situated close by. Graduate students have access to a wide variety of research tools ranging from analytical centrifuges and electron microscopes to a herbarium of 500,000 specimens and a new paleobotany laboratory with an outstanding collection of teaching and research materials. Nearby facilities available for field research include University-owned woodlands, prarie, and farmland; in southeastern Illinois, the University maintains a large experiment station. Among other noteworthy campus facilities are computer services, a central electron microscope laboratory, and an excellent biological sciences library.

Departmental Diagnostic Examination. At the beginning of his first fall semester, a new graduate student is required to take a written examination that is used to determine his level of information in the following areas: (1) ecology, (2) genetics, (3) morphology, (4) physiology, and (5) systematics. The results of the examination are used by the student's adviser to recommend future graduate courses, and no permanent record is made of the results.

Students with deficient preparation in any of the five areas will be expected to remove the deficiency by (1) independent study and reexamination or (2) taking course work in the appropriate area and earning grades of B or better. The adviser can substitute alternative areas of study for two of the five areas listed above in planning the student's degree program for the M.S. and Ph.D. degrees.

Master of Science. Candidates for this degree are expected to fulfill the requirements of the Graduate College (see pages 36 to 39) and to remove any deficiencies revealed by the diagnostic examination. A thesis may be required for the Master of Science degree at the option of the candidate's adviser.

A student may engage in graduate work toward the Doctor of Philosophy without having obtained a master's degree.

Doctor of Philosophy. Candidates for this degree are expected to fulfill the requirements of the Graduate College (see pages 39 to 41) and to remove any deficiencies revealed by the diagnostic examination. The exact content of the program is determined by the candidate and his major adviser.

GRADUATE FACULTY

Professors: J. B. Hanson (Head of Department), L. M. Black, G. N. Jones, J. R. Laughnan, E. I. Rabinowitch, M. E. Reichmann, D. P. Rogers, D. M. Steffensen.

Associate Professors: Z. B. Carothers, Govindjee, J. F. Nance, D. J. Paolillo, T. L. Phillips.

Assistant Professors: J. S. Boyer, A. W. Haney, L. R. Hoffman, R. MacLeod, W. W. Payne, M. L. Sargent.

COURSES FOR GRADUATES

402. Molecular Genetics. See Zoology 402. ¾ unit. Prerequisite: Microbiology 330 or equivalent. Atwood, Spiegelman, Woese.

403. Physiology of Fungi. Same as Plant Pathology 403. The germination, growth, metabolism, and sporulation of fungi; physiology of the fungi as related to parasitism, antibiotic production, vitamin assay, and industrially important products. The nature of fungicidal activity is discussed. 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Organic chemistry or biochemistry; mycology, plant pathology, or microbiology. Gottlieb.

405. Microbiological Genetics. See Microbiology 405. ¾ unit. Prerequisite: Microbiology 330; mathematics through calculus, or consent of instructor. Atwood, Nanney, Spiegelman.

410. Botany Discussions. All graduate students in botany, except those with conflicting teaching assignments, are required to register in and attend the general seminar. No credit is given except to those students presenting the results of their Ph.D. thesis research. 0 or ¼ unit. Staff.

413. Discussions in Plant Physiology. ¼ unit. Staff.

414. Discussions in Plant Morphology and Taxonomy. ¼ unit. Staff.

418. Discussions in Plant Ecology and Plant Geography. Developments in ecology and plant geography, with emphasis on one special division. ¼ unit; total credit is limited to 1½ units. Prerequisite: Graduate standing in botany, entomology, geography, or zoology. Bazzaz, Haney.

419. Discussions in Photosynthesis and Related Topics. ¼ unit. Prerequisite: Consent of instructor. Govindjee.

421. Cytogenetics. Same as Zoology 421. Chromosome theory: the structure, behavior, and physiology of chromosomes in heredity and development. 1 unit. Prerequisite: Biology 210, or Microbiology 330, or consent of instructor. Steffensen.

424. Mineral Nutrition of Plants. Same as Agronomy and Horticulture 424. A study of the uptake, transport, and metabolic utilization of mineral nutrients by plants. The scope of the course is to present the essentiality of various anions and cations in the light of metabolic activity and constituency in functional plant compounds. Major emphasis is placed on metabolic activity and function of the elements. 1 unit. Prerequisite: Botany 330 or consent of instructor. Hageman.

427. Discussions in Mycology. A seminar course designed for discussion of current research activites in the morphology, taxonomy, and physiology of fungi, especially the nonparasitic forms. ¼ unit. Prerequisite: Consent of instructor. Rogers, Tuveson.

433. Advanced Physiology of Growth, Responses, and Reproduction. 1 unit. Prerequisite: Botany 330 or equivalent. Dickinson, McCollum, Nance, Wilson.

436. **Advanced Plant Physiology: Photosynthesis.** Same as Agronomy 436. A lecture and laboratory course dealing with physiological, biochemical, and biophysical aspects of photosynthesis. 1 unit. Prerequisite: One year each of college biology, chemistry, and physics, or consent of instructor. GOVINDJEE, OGREN.

442. **Environmental Plant Physiology.** A lecture course dealing with the interaction of plants and environment at the level of the whole organism, extending to the cell and the community. Heat and mass transfer, plant and soil potentials, and the effects of light on growth are emphasized. ¾ unit. Prerequisite: Chemistry 133, general physics, general or plant physiology, and consent of instructor. BOYER.

443. **Environmental Plant Physiology Laboratory.** A laboratory course illustrating quantitative techniques for studying the response of whole plants to environment. Experiments are designed to illustrate methods of gas analysis and advanced techniques for measuring energy balance, potentials, and matter flow through plants. ¾ unit. Prerequisite: Chemistry 133, general physics, general or plant physiology, and consent of instructor; credit or registration in Botany 442. BOYER.

450. **Phycology.** Morphology, physiology, genetics, taxonomy, and ecology of algae. 1 unit. Prerequisite: One year of botany or another biological science, or consent of instructor. HOFFMAN.

460. **Advanced Taxonomy of Flowering Plants, I.** Phylogenetic study of flowering plants; relationship of the principal orders and families; problems of nomenclature; identification of specimens. ½ or 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Botany 260 or one year of botany or another biological science, or consent of instructor. JONES.

461. **Advanced Taxonomy of Flowering Plants, II.** The application of cytology, ecology, genetics, and morphological analyses to the study of evolution and the natural relationships of populations as exemplified by species of higher plants. 1 unit. Offered in 1970-1971 and in alternate years. Prerequisite: Botany 260 and Biology 210, or equivalent; consent of instructor. PAYNE.

471. **Advanced Mycology: Special Groups.** The several classes of fungi and their activities are considered in successive semesters. Special groups within these classes may be selected for concentrated study, depending upon the student's interest in mycology. ½ unit. Prerequisite: Botany 372 or consent of instructor. ROGERS.

482. **Ecological Methods.** Field and laboratory methods used in ecology. 1 unit. Offered in 1970-1971 and in alternatie years. Prerequisite: One year of botany including Botany 381 or equivalent. BAZZAZ, HANEY.

485. **Plant Geography of North America.** Study of principles of plant geography, plant distribution in relation to environment, and vegetational units of North America. 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Botany 381 or equivalent. BAZZAZ, HANEY.

493. **Advanced Studies in Botany.** ½ to 2 units. Not more than one unit may be applied toward the Graduate College master's degree requirement of three units of course work at the 400 level. Work may be taken in the following fields:

(a) **Anatomy.** CAROTHERS, PAOLILLO.
(b) **Biochemical Cytology.** STEFFENSEN.
(c) **Bryology.** JONES.
(d) **Cytogenetics and Speciation.** DEWET.
(e) **Ecology.** BAZZAZ, HANEY.
(f) **Genetics.** LAUGHNAN, SARGENT, TUVESON.
(g) **Morphogenesis.** PAOLILLO.

(h) **Morphology.** CAROTHERS, PHILLIPS.
(i) **Mycology.** ROGERS, TUVESON.
(j) **Paleobotany.** PHILLIPS.
(k) **Photosynthesis.** GOVINDJEE, SYBESMA.
(l) **Phycology.** HOFFMAN.
(m) **Physiology.** BOYER, HANSON, NANCE, SARGENT.
(n) **Taxonomy.** JONES, PAYNE.
(o) **Ultrastructure.** CAROTHERS, HOFFMAN, PAOLILLO.
(p) **Virology.** BLACK, MACLEOD, REICHMANN.

499. Thesis Research. Individual work under supervision of members of the staff in their respective fields. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Individual Topics. For seniors and first-year graduate students who wish to study individual problems and topics not assigned in other courses. Graduate students may not offer more than one unit in Botany 300 toward a master's degree. ¼ or ½ unit. Prerequisite: Botany 100; ten hours of advanced work in botany or another biological science. STAFF.

304. General Plant Morphology. A lecture and laboratory course dealing with the structure, reproduction, and evolution of representative algae, fungi, bryophytes, pteridophytes, gymnosperms, and angiosperms. 1 unit. Prerequisite: Botany 100, or Biology 110 and 111, or Biology 100 and 101, or Biology 151 and 251, or consent of instructor. CAROTHERS, HOFFMAN, ROGERS.

305. Comparative Morphology—Embryophytes. A lecture and laboratory course dealing with the development, structure, reproduction, and evolution of bryophytes, lower vascular plants, and gymnosperms, with an introduction to angiosperms. One or two field trips. 1 unit. Prerequisite: Botany 100 or equivalent. PAOLILLO, PHILLIPS.

325. Paleobotany. Same as Geology 325. The structure, phylogeny, and geological distribution of representative fossil plants. Two or three field trips. 1 unit. Prerequisite: Botany 100 or Biology 100 and 101, and Geology 101; or consent of instructor. PHILLIPS.

330. Plant Physiology. A general course concerned with plant functions including water relations, mineral nutrition, metabolism, growth, and reproduction. ½ unit. Prerequisite: Chemistry 133 and Botany 100, or Biology 110 and 111, or Biology 100 and 101, or Biology 151 and 251. NANCE.

331. Experimental Cytology. Same as Zoology 331. Organization of cells of higher organisms with emphasis on the relationships between structure and function. The laboratory stresses modern cellular techniques. 1 unit. Prerequisite: Biology 151, 210, or 251; consent of instructor. DAVENPORT, STEFFENSEN.

335. Plant Physiology Laboratory. A laboratory course in plant physiology. A supplement to Botany 330; serves the needs of those interested in acquiring familiarity with techniques of plant physiology. ½ unit. Prerequisite: Credit or registration in Botany 330 or equivalent. STAFF.

340. Histological Technique. Survey of techniques used in the preparation of plant tissues for microscopical examination. 1 unit. Prerequisite: One year of botany or ten hours of zoology; consent of instructor. BLACK, MACLEOD.

341. Field Ecology. Study of plant communities in various sections of North America during spring vacation (trips rotate on a three-to-five-year basis); outdoor cooking and camping; transportation in University cars. ¼ unit; may be repeated for a maximum of ¾ unit. Prerequisite: One of the following—Botany 260, 366, 381, 385; consent of instructor. HANEY.

345. Plant Anatomy. Study of the internal structure of vascular plants, with special emphasis on development, function, and evolutionary history. 1 unit. Prerequisite: One year of botany. CAROTHERS.

351. Viruses, I. Same as Microbiology and Zoology 351. The study of viruses emphasizing the bacteriophages; statistical, physical, biological, and chemical properties of viruses; analysis of host-virus interactions and of viral genetics. ¾ unit. Prerequisite: Organic chemistry; biochemistry and calculus recommended. DRAKE.

352. Viruses, II. Same as Microbiology and Zoology 352. Extension of the principles developed in Botany, Microbiology, or Zoology 351 to the study of special plant, animal, and bacterial virus systems. ¾ unit. Prerequisite: Botany, Microbiology, or Zoology 351 or consent of instructor; biochemistry and calculus recommended. BLACK, REICHMANN.

366. Field Botany. Identification and classification of native and naturalized flowering plants of eastern North America. S; ½ or 1 unit. Prerequisite: One course in botany; consent of instructor. STAFF.

372. General Mycology. Structure, classification, and identification of fungi, including those of economic importance. 1 unit. Prerequisite: One year of botany, entomology, microbiology, or zoology. ROGERS.

381. Plant Ecology. Principles of ecology, exemplified by vegetation and environments of Illinois. 1 unit. Prerequisite: Botany 260 or equivalent. BAZZAZ.

Entomology

The Department of Entomology offers graduate work leading to the Master of Science and Doctor of Philosophy. Admission requires a grade-point average of at least 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

Previous training in entomology is not essential. It is recommended that students who intend to study for advanced degrees in entomology gain a thorough grounding in the fundamentals of physical and biological science, mathematics, and the liberal arts.

Master of Science. A candidate for this degree is required to demonstrate competence in insect bionomics, control, morphology, physiology, and taxonomy. This may be done by completing with a grade of B or better courses in the following series: Entomology 302, The Classification of Insects; 319, Insect Control, or 420, Insect Toxicology; 322, Insect Bionomics; 410, Insect Morphology; and 422, Insect Physiology; by passing examinations in these subjects; or by a combination of these methods. Proficiency examinations are given by the department in the week before each semester begins. Electives, including thesis research, make up the balance of the eight-unit requirement. If research credit is presented, a thesis is required.

Doctor of Philosophy. A candidate for this degree must satisfy the requirements for the Master of Science in Entomology. The rest of the candidate's program is determined in consultation with his adviser and representatives of the department or departments in which the minor courses are taken. All minor credit must be earned outside the Department of Entomology. The minor or minors are generally selected from the biological and physical sciences.

The chief areas of specialization in the department are behavior, bionomics, economic entomology, medical entomology, morphology, physiology, taxonomy, and toxicology. The facilities of both the department and the State Natural History Survey are available for advanced study in these areas.

GRADUATE FACULTY

Professors: C. W. KEARNS (Head of Department), G. FRAENKEL, S. FRIEDMAN, W. R. HORSFALL, W. H. LUCKMANN, R. L. METCALF, H. H. ROSS, R. B. SELANDER, J. G. STERNBURG.

Associate Professors: A. W. GHENT, E. R. JAYCOX, J. R. LARSEN, G. P. WALDBAUER.

Assistant Professor: JUDITH H. WILLIS.

COURSES FOR GRADUATES

410. Insect Morphology. A comprehensive study of the internal and external structure of insects from the comparative viewpoint. 1 unit. Prerequisite: Biology 111; consent of instructor. LARSEN, STERNBURG.

413. Medical and Veterinary Entomology. Training in recognition, classification, methods of injury, habits, and control or destruction of insects, mites, and ticks which are predators, parasites, or disseminators of disease among men and domestic animals. 1 unit. Prerequisite: Entomology 103 or 302; or Zoology 320. HORSFALL.

420. Chemistry and Toxicology of Insecticides. Designed to provide the fundamental information available concerning the mode of action, the relationship of chemical structure to toxicity, and the physiological explanation of the chemical poisoning of insects. 1 unit. Prerequisite: One year of biology, or equivalent in animal sciences; a course in organic chemistry. KEARNS, METCALF, STERNBURG.

422. Insect Physiology. A study of the principal physiological and biochemical functions of insects, exclusive of sensory functions. 1 unit. Prerequisite: Entomology 302, 410; a course in organic chemistry. FRIEDMAN, LARSEN.

423. Insect Behavior. An analysis of the physiological basis of insect behavior, including a thorough study of the various sensory systems. 1 unit. Prerequisite: Entomology 301 or equivalent. WALDBAUER.

424. Advanced Insect Physiology. A comprehensive study of the physiological and biochemical interactions between the insect and its environment including: sensory mechanisms, attractants and repellants, nutritional specialization, intermediary metabolism, energy production and utilization, metabolic activity accompanying functional changes, process controls. 1 unit. Prerequisite: Entomology 422; Chemistry 350. FRIEDMAN, LARSEN.

426. Seminar in Entomology. Discussions, reviews, and appraisals of special topics in the field of entomology. ¼ to 1 unit. Prerequisite: Consent of instructor. FRAENKEL, FRIEDMAN, HORSFALL, KEARNS, LARSEN, MACLEOD, METCALF, ROSS, SELANDER, STERNBURG, WALDBAUER, WILLIS.

499. Thesis Research. Work may be taken in the following subjects: morphology and embryology of insects, applied entomology, systematic entomology, biology and ecology of insects, insect toxicology, and insect physiology. 0 to 4 units. FRAENKEL, FRIEDMAN, GHENT, HORSFALL, JAYCOX, KEARNS, LARSEN, LUCKMANN, MACLEOD, METCALF, ROSS, SELANDER, STERNBURG, WALDBAUER, WILLIS.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Introduction to Entomology. Devoted to integrated studies of the principal morphological and physiological characteristics of insects. 1 unit. Prerequisite: Biology 111 and Chemistry 101, or consent of instructor. FRIEDMAN, SELANDER, STERNBURG.

302. Classification of Insects. Presents a comprehensive survey of the systematics and phylogeny of the orders and principal families of insects, together with

practical experience in identification of these taxa. 1 unit. Prerequisite: Consent of instructor. SELANDER.

306. **Special Problems.** For students ready to take up some special investigation as the beginning of a thesis problem for an advanced degree. ¼ to 1 unit. Prerequisite: Consent of instructor. STAFF.

312. **Entomology for Teachers.** Recognition of the chief orders of insects in their immature and adult stages, how they develop, life cycles, food, habitats, adaptations for feeding, oviposition, movement, protection, defense, making sound and other functions, interrelation with other organisms, environment, and social life. A collection of insects is identified, mounted, and labeled. Field trips, laboratory, and discussions. S; ½ unit. Prerequisite: One year of biology, botany, zoology, or equivalent.

319. **Fundamentals of Insect Control.** The course emphasizes the principles that underlie effective control practices, rather than the details of methods used against specific pests. Both environmental and chemical factors involved in insect control are considered from their basic aspects. 1 unit. Prerequisite: Biology 111 and Chemistry 101, or equivalent. HORSFALL, KEARNS, METCALF.

322. **Insect Bionomics.** This phase of the biology of insects deals with life history and conditions of environment that favor abundance of insects representative of various habitats. 1 unit. Prerequisite: Entomology 103, or 302, or Zoology 320. HORSFALL.

361. **Individual and Group Behavior of Honey Bees.** See Horticulture 361. ½ unit. Prerequisite: One semester of entomology or zoology. JAYCOX.

Microbiology

The Department of Microbiology offers graduate work leading to the Master of Science and Doctor of Philosophy. Students electing microbiology as a major for an advanced degree must have had, in addition to formal training in general bacteriology or microbiology, chemistry through quantitative analysis and organic chemistry, and fifteen hours of physical or biological sciences. Mathematics through calculus is strongly recommended.

Students who have fulfilled these requirements may apply for admission if they have a grade-point average of at least 4.0.

MOLECULAR BIOLOGY (Biophysical Chemistry)

The Department of Microbiology in collaboration with the Department of Chemistry and Chemical Engineering offers an area of specialization in biophysical chemistry. The program is flexible and provides the doctoral candidate with basic training in physical biochemistry and biology. Students electing this area should possess a solid background in physics and mathematics. Details of the curriculum are decided individually on the basis of the past experience and interests of the student. It is expected, however, that he will fulfill minor requirements in physical chemistry or biochemistry.

The major research areas are: (1) molecular basis of gene function; (2) structure and activities of proteins and nucleic acids; (3) intracellular organization and distribution of nucleoprotein components; (4) biosynthetic mechanisms of macromolecular replication; (5) immunochemistry.

GRADUATE FACULTY

Professors: L. L. CAMPBELL (Head of Department), K. C. ATWOOD, M. P. BRYANT, F. M. CLARK, R. D. DEMOSS, R. E. KALLIO, Z. N. ORDAL, S. SPIEGELMAN, P. S. SYPHERD, R. S. WOLFE, M. J. WOLIN.

Associate Professors: J. W. Drake, R. C. Meyer, J. T. Wachsman, C. R. Woese.
Assistant Professor: S. Kaplan.

COURSES FOR GRADUATES

402. Molecular Genetics. Same as Botany and Zoology 402. The nature of the gene, its mode of action, the mechanism of autosynthesis, the organization of the genetic material, and the regulation of gene action. ¾ unit. Prerequisite: Microbiology 330 or equivalent. Atwood, Spiegelman, Woese.

405. Microbiological Genetics. Same as Botany and Zoology 405. Breeding systems and recombinational analysis in microorganisms, with particular emphasis on protozoa and fungi. ¾ unit. Prerequisite: Microbiology 330; mathematics through calculus, or consent of instructor. Spiegelman.

409. Cultivation and Properties of Microorganisms. Nutritional and metabolic properties of the major groups of microorganisms; a comparative study of the ecology, selective isolation, and cultivation of bacteria. Laboratory. 1 unit. Prerequisite: Chemistry 355 or equivalent; credit or registration in Microbiology 309; consent of instructor. Wolfe, Wolin.

412. Advances in Microbiology. Discussions of current research in several areas of microbiology. Discussions cover the following areas: (a) general microbiology, (b) microbial physiology and metabolism, (c) immunochemistry, (d) molecular genetics. ¼ unit. May be repeated for a maximum of one unit. Prerequisite: Consent of instructor. Staff.

419. Animal Virology. Same as Veterinary Medical Science 419. A discussion-laboratory with major emphasis on host-parasite relationships, natural history, and epidemiology supplemented with appropriate laboratory techniques as they pertain to the major groups of animal viruses. ¾ unit. Prerequisite: Microbiology 326 and 327 or Veterinary Medical Science 331 and 332; Chemistry 350 or 354; consent of instructor.

420. Chemistry of Microbic Processes. The properties of microorganisms with emphasis on the metabolic pathways and chemical processes involved in the release of energy in the dissimulation of substrates by fermentation and respiration, and in the synthesis of cellular constituents. The metabolic types represented by microorganisms including the heterotrophic, autotrophic, and photosynthetic patterns are included. ¾ unit. Prerequisite: Microbiology 309 or 330 and Chemistry 234 and 350, or equivalent; consent of instructor. DeMoss.

451. Experimental Virology and Microbial Genetics. Experiments on the biology, replication, and genetics of bacteriophages and bacteria, with emphasis on experimental design by the students. 1 unit. Prerequisite: Microbiology 351; consent of instructor. Drake.

490. Individual Problems. ½ to 2 units. Prerequisite: Consent of instructor. Staff.

495. Seminar. Required of all graduate students whose major is microbiology. 0 or ¼ unit. Prerequisite: Ten hours of microbiology; consent of instructor. Staff.

499. Thesis Research. 0 to 4 units. Atwood, Bryant, Campbell, Clark, DeMoss, Drake, Gunsalus, Kallio, Kaplan, Meyer, Ordal, Spiegelman, Sypherd, Wachsman, Woese, Wolfe, Wolin.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

309. Comparative Microbial Chemistry. Emphasis is placed on comparative biochemical activity and other chemical characteristics as a basis for the discussion

of the features of major groups of microorganisms. Comparison of the energy metabolism of the microbial groups is stressed. Lecture. ½ unit. Prerequisite: Chemistry 350 or equivalent. WOLFE, WOLIN.

311. **Food and Industrial Microbiology.** The relationship of microorganisms to food manufacture and preservation and to industrial fermentation and processing and to sanitation. Lecture. ¾ unit. Prerequisite: Microbiology 101 or 201 or 309, or equivalent, and credit or registration in organic chemistry; or consent of instructor. CLARK.

312. **Techniques of Applied Microbiology.** A consideration, through experimentation, of the properties of the bacteria, yeasts, molds, and actinomycetes which are important to industrial processes. The methods of control of microbial processes in industry and sanitation are explored. Laboratory. ½ unit. Prerequisite: Credit or registration in Microbiology 311. CLARK.

326. **Pathogenic Bacteriology.** A study of the parasitism and pathogenic microorganisms: classification, morphology, cultural requirements and reactions, toxins, diagnostic tests, methods of differentiation and recognition, and the diseases bacteria cause. Lectures and laboratory. 1 unit. Prerequisite: Microbiology 101 or 201; organic chemistry. MEYER.

327. **Immunochemistry.** A survey of the field of immunology with emphasis on its chemical aspects. Lectures and laboratory. 1 unit. Prerequisite: Credit or registration in biochemistry or consent of instructor. VOSS.

330. **Metabolic Regulation and Genetics of Microorganisms.** Modern contributions to the science of microbiology, including considerations of the micro- and macro-molecular anatomy of the bacterial cell, the physiological and genetic behavior of microorganisms, and the role of bacterial viruses as agents involved in the transfer of genetic information. Lecture. ¾ unit. Prerequisite: Microbiology 101 or 201, or equivalent; credit or registration in biochemistry or consent of instructor; calculus strongly recommended. SYPHERD, WOESE.

351. **Viruses I.** Same as Botany and Zoology 351. The study of viruses emphasizing the bacteriophages; statistical, physical, biological, and chemical properties of viruses; analysis of host-virus interactions and of viral genetics. ¾ unit. Prerequisite: Organic chemistry; biochemistry and calculus recommended. DRAKE.

352. **Viruses, II.** Same as Botany and Zoology 352. Extension of the principles developed in Microbiology, Botany, and Zoology 351 to the study of special plant, animal, and bacterial virus systems. ¾ unit. Prerequisite: Botany, Microbiology, and Zoology 351, or consent of instructor; biochemistry and calculus recommended. BLACK, MACLEOD, REICHMANN.

Physiology and Biophysics

The Master of Science and Doctor of Philosophy are granted in both physiology and biophysics.

PHYSIOLOGY

Applicants for graduate study in physiology are screened by an admissions committee and normally are admitted if their junior-senior grade-point average is 4.0 or better (scale of 5), and if their background training is adequate. Applicants with averages between 3.5 and 4.0 are considered, and may be admitted if their performance indicates adequate improvement, and if letters of recommendation indicate ability for graduate work. All transfer graduate students are judged on the

basis of past performance. All new graduate students are interviewed by the physiology graduate student counselor. During the period when they are unassigned to a sponsor, new students are advised by the counselor concerning regulations and requirements of the department, the Graduate College, and the University; also concerning introductory courses in this and allied departments and any deficiencies in preparation.

Master of Science. Normally, students take a master's degree after completion of eight units of graduate study. During the master's program, students are expected to make up any undergraduate deficiencies. The program of study usually includes (a) Physiology 401, 402, 403, and 404; (b) two or three units from other departments (usually including Chemistry 350 and 355) and from the seminar and specialized courses in this department; and (c) one or two units of Physiology 491, Individual Topics. For students whose undergraduate preparation has been deficient, additional courses may be recommended. Each student must submit a report based on original research; usually the research and report are part of the work done in Physiology 491. During the semester when the requirements for the master's degree are completed, the candidate takes an oral examination; this is a general examination and includes a discussion of the research report. The examination is administered by the Physiology Qualifying Committee.

Doctor of Philosophy. The student must receive a grade of A or B in each of the 400-series (Physiology 401, 402, 403, 404) courses. If a student receives a grade of C in *one* of these courses, he must take the course over and receive a grade of B or better or, if approved by the Qualifying Committee, submit satisfactory evidence that he has achieved adequate mastery of the areas in which he performed poorly. If a student received a grade of C in *two* of the 400-series courses, he is not qualified for the Ph.D. program. The examination includes evaluation and discussion of a formal research report written by the student, and may serve as the general oral examination for the M.S. degree. A student may receive the M.S. degree but be found unqualified for the Ph.D. program. Final decision on admission to the Ph.D. program is made by the department faculty and is based not only upon the findings of the examining committee, but on the total academic record, the opinion of the sponsor concerning research potential, and the nature of the student's objectives and motivation.

Every candidate for the Ph.D. in Physiology is required to obtain a firm background in the general areas of mammalian, comparative, and cellular physiology, as well as a high degree of expertise in his area of specialization. He is also expected to develop proficiency in other appropriate disciplines, such as biochemistry, physical chemistry, statistics, and the history and philosophy of science.

The preliminary examination is taken after completion of at least sixteen units of graduate course work, completion of all courses specified by the student's advisory committee, and after satisfying the foreign language requirement. A student is also expected to have completed sufficient research so that he can present a firm thesis proposal to the examining committee. The emphasis in the preliminary examination is on ability to synthesize and generalize, and to plan research; it is intended to be more a test of critical scholarly ability than of detailed factual knowledge. The examination covers, but is not necessarily limited to, the areas of mammalian, comparative, and cellular physiology, and the concepts of disciplines related to the candidate's area of specialization.

Minor. Graduate students in other departments are assigned by the physiology graduate student counselor to a departmental minor adviser according to their interests. Requirements are as follows: sole minor, four units including two from the 401-404 sequence; split minor, two units of which one is at the 400 level. A sequence of courses within one area of physiology is desirable for a minor.

BIOPHYSICS

The objective of the program in biophysics is to give the student sufficient training in physics, chemistry, and biology to enable him to apply the conceptual, instrumental, and mathematical approaches of the physical scientist to the solution of biological problems. The graduate curriculum is administered by a committee representing both the physical and the biological sciences. The curriculum is designed primarily for students entering with a master's degree in a physical science but students with less than a master's degree in physical sciences or biology may be eligible.

Admission requirements for the latter are one year of college biology, one year of college physics, quantitative analysis (five hours), organic chemistry (five hours), and calculus (six hours). However, any deficiencies can be corrected while in training. Applicants must have a grade-point average of at least 4.0.

Master of Science. To obtain the Master of Science, the student must offer at least eight units in biophysics and related subjects. The required courses are Biophysics 401, 402, and two units of additional biophysics courses; a thesis or examination in a special field is also required.

For students whose major training has been in the physical sciences, the balance of courses should be selected from the biological science courses; students from the biological sciences select courses from the physical science courses. Candidates for the Master of Science must pass a general examination.

Doctor of Philosophy. A flexible approach is made to curriculum requirements. Students are required, after approximately eight units of graduate study, to pass a qualifying examination, and after sixteen units, to pass a preliminary examination. At some time during the doctoral program, the candidates will be expected to teach for two semesters at half time (or the equivalent). An acceptable course program is given below:

(1) Mathematics, physics, and chemistry: Mathematics 343 or 345; Physics 321, 341, 342, and 381; Chemistry 342, 343, 344, and 345 (a one-year sequence including lectures and laboratory), and Chemistry 350 and 355. Certain of the required physics courses can be waived, upon approval of the committee, in cases where the student has had comparable training in advanced courses in physical chemistry. A knowledge of colloidal and macromolecular phenomena equivalent to one semester of work comparable to Chemistry 346 is necessary for work in biophysics.

(2) Biology: Three units of graduate course work in one of the major areas of biology, determined by the research interests of the student. At least one course in genetics should be included as part of the three-unit requirement in biology.

(3) Biophysics: Biophysics 401 or equivalent; Biophysics 402 and two additional courses in biophysics (other than research).

(4) Minor areas: Students entering from the biological sciences may declare a minor in physics or chemistry, or a minor in both, utilizing required courses in these fields, while students entering from the physical sciences may declare a sole minor in a selected field of biology. Other minors are possible but must meet the approval of the committee.

Minor. Subject to the approval of the committee, candidates for the Doctor of Philosophy in other fields may take a minor in biophysics.

GRADUATE FACULTY

Professors: C. L. Prosser (Head of Department), H. W. Ades, J. D. Anderson, W. R. Ashby, H. S. Ducoff, F. Dunn, J. Gorski, R. E. Johnson, A. V. Nalbandov, F. R. Steggerda, A. B. Taylor, H. I. Teigler, H. M. Von Foerster.

Associate Professors: D. E. Buetow, Govindjee, J. E. Heath, B. A. Hertig, J. R. Larsen, S. G. Stolpe, C. Sybesma, J. S. Willis.
Assistant Professors: D. W. Badger, E. S. Kirk, Y. Matsumoto, D. C. Sweeney.

Physiology

COURSES FOR GRADUATES

401. Physiology of Systems and Organs. Analysis of organization and function of vertebrate systems, combining the viewpoints of traditional cellular, comparative, mammalian, and human physiology; nervous, circulatory, digestive, and excretory systems; gross metabolism. 1 unit. Prerequisite: One year of college-level physics; chemistry through organic; an upper division course in physiology; physical chemistry and biochemistry recommended; knowledge of calculus presumed. Staff.

402. Comparative and Adaptational Physiology. Analysis of mechanisms of adaptation to the environment and to environmental stress, combining the viewpoints of traditional cellular, mammalian, and human physiology, with particular emphasis on the comparative approach. Homeostatic theory, nutrition, osmotic and ionic regulation, respiration and metabolism, temperature relations, sense organs, contractile systems. 1 unit. Prerequisite: One year of college-level physics; chemistry through organic; an upper division course in physiology; physical chemistry and biochemistry recommended; knowledge of calculus presumed. Staff.

403. Cellular and Molecular Physiology. Physicochemical analysis of cellular function and consideration of the implications of the properties of cells for the physiology of multicellular animals. Cell and its organization, cell and the organism, protein structure and specificity, regulation of cell metabolism, cellular basis of hormone action, cell membranes, bioelectrics, muscle. 1 unit. Prerequisite: One year of college-level physics; chemistry including physical and biochemistry; an upper division course in physiology; knowledge of calculus presumed. Staff.

404. Physiological Measurements. Lectures and laboratories concerned with an introduction at a graduate level to current research techniques in the physiological sciences. The laboratories are problem-oriented, and students select four to six special topics, at least one of which must be in each of the following major areas of physiology: (1) nervous system and muscles; (2) mammalian and human; (3) adaptation and radiation biology, and comparative physiology; (4) molecular, cellular, and endocrinological physiology. Within each area there are problems which fall into one or more of the following experimental categories: electrical-mechanical, chemical, and surgical. Selection of problems is done in conjunction with the course secretary so that the student obtains familiarity with techniques in each of these experimental categories and can devote some time to material of consequence relating to his own research interests. Emphasis is placed on the ability to work independently, and students give oral and written reports of their experimentation. 1¼ units. Prerequisite: Chemistry 355 or equivalent, or consent of instructor. Staff.

410. Mammalian Physiology Seminar. Current trends in mammalian physiology. ½ unit. Prerequisite: Physiology 401 and 402, or equivalent; consent of instructor. Kirk, Steggerda.

412. Advanced Endocrinology. Same as Animal Science, Dairy Science, and Zoology 412. Seminar, lectures, student reports, and discussions of recent advances in endocrinology. The course may be repeated for credit not to exceed a total of

two units. ½ unit. Prerequisite: Physiology 312; consent of instructor. GORSKI, NALBANDOV.

413. Experimental Mammalian Physiology, I. The physiological applications of experimental mammalian surgery. 1 unit. Prerequisite: Physiology 401 and 402, or equivalent; consent of instructor. STEGGERDA.

414. Experimental Mammalian Physiology, II. The physiological applications of experimental pharmacodynamics. 1 unit. Prerequisite: Physiology 401 and 402, or equivalent; consent of instructor. STEGGERDA.

416. Structure and Function of the Nervous System. The understanding of nervous function through the experimental approach. 1 unit. Prerequisite: Two semesters of physiology courses beyond the elementary level; semesters of general physics; consent of instructor. ADES.

421. Gross Human Anatomy. A general survey of the structures of the human body with emphasis on the relations between form and function. 1 unit. Prerequisite: One semester of embryology; consent of instructor. STOLPE.

431. Experimental Radiobiology. Laboratory exercises in irradiation procedures and in the examination of biological responses to ionizing radiations. 1 unit. Prerequisite: Physiology 331 or equivalent; consent of instructor. DUCOFF.

441. Advanced Comparative Physiology. Same as Zoology 441. Seminar, lectures, student reports, discussions. ½ unit. Prerequisite: Consent of instructor. STAFF.

442. Advanced Comparative Physiology Laboratory. Same as Zoology 442. Laboratory experiments presenting comparative principles in osmotic and ionic regulation, respiration and metabolism, temperature regulation of animals, physiology of circulatory systems, of muscle, of sense organs and nervous systems. 1 unit. Prerequisite: Physiology 402, 403, and 404; credit or registration in Physiology 441. PROSSER.

451. Advanced Cellular Physiology. Same as Zoology 451. Seminar, lectures, student reports, discussions. ½ unit. Prerequisite: Consent of instructor. STAFF.

461. Fundamentals of Bioclimatology. Same as Geography 461. The effects of physical factors (such as barometric pressure, temperature, humidity, radiation, and air movement) on physiological processes in mammals; and the application of meterological, climatological, and geographical techniques in physiological studies. ¾ unit. Prerequisite: Consent of instructor.

462. Experimental Bioclimatology. Same as Geography 462. Laboratory work and demonstrations on methods of measuring meterological factors, of clinical thermometry, and partitional calorimetry; laboratory work on physiological adjustments of man to heat, cold, and high altitude. ½ unit. Prerequisite: Physiology 301, or 401 and 402; credit or registration in Physiology 461.

464. Advanced Human Bioclimatology. Same as Geography 464. Topics in human bioclimatology and medical geography, such as climatic determinism, meteorotropism, the weather elements as stresses, and acclimatization. ½ unit. Prerequisite: Physiology 461.

470. Human Pathologic Physiology. Disturbances of function in tissues and organs and their relationship to the pathogenesis of human disease. ¾ unit. Prerequisite: Two semesters of advanced physiology; one semester of biochemistry; consent of instructor. JOHNSON, TEIGLER.

472. Human Physiology Seminar. Topics of current emphasis in human physiology. ½ unit. Prerequisite: Two semesters of advanced physiology; one semester of biochemistry; consent of instructor. JOHNSON, TEIGLER.

473. Ergonomics Seminar. Same as Industrial Engineering 473. Topics in ergonomics are explored in depth, such as effects of vibration on human performance and biomechanics of the hand. ½ unit. Prerequisite: Industrial Engineering 306 or consent of instructor. HERTIG, JOHNSON.

491. Individual Topics. For graduate students who wish to study individual problems or topics not assigned in other courses. ½ to 2 units. Prerequisite: Approval of department. STAFF.

499. Thesis Research. 0 to 4 units. Research may be conducted in the following areas, with the consent of the instructor:

(a) **Cellular Physiology and Radiobiology.** ANDERSON, BUETOW, DUCOFF, GORSKI, PROSSER, TAYLOR, WILLIS.
(b) **Comparative Physiology.** ANDERSON, HEATH, LARSEN, PROSSER, SWEENEY, WILLIS.
(c) **Mammalian Physiology.** ADES, KIRK, NALBANDOV, STEGGERDA.
(d) **Human Anatomy and Human Physiology.** JOHNSON, STOLPE.
(e) **Endocrinology.** FOSTER, GORSKI, NALBANDOV, STOLPE.
(f) **Neurophysiology.** ADES.
(g) **Bioclimatology.**
(h) **Environmental and Stress Physiology.** HERTIG, JOHNSON.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. General Physiology. A consideration from the standpoint of experimental biology of functions that are common to most living organisms. ¾ unit. Prerequisite: Biology 111 or 251, or equivalent; one year each of college-level mathematics and physics; chemistry through organic. ANDERSON, STAFF.

302. Animal Physiology. Organ physiology of animals with emphasis on homeostasis and physiological interactions of animals with their environment. ¾ unit. Prerequisite: Biology 111 or 251, or equivalent; one year each of college-level mathematics and physics; chemistry through organic. ANDERSON, BADGER, STAFF.

303. General Physiology Laboratory. An introduction to experimentation with cellular functions that are common to most living organisms with emphasis on biochemical, radioactive tracer, electrical and mechanical recording techniques. ¼ unit. Prerequisite: Credit or registration in Physiology 301.

304. Experimental Physiology Laboratory. Introduction to problems and techniques for studying the physiology of organ systems. ¼ unit. Prerequisite: Credit or registration in Physiology 302.

305. Principles of Ergonomics. Same as Industrial Engineering 305. Concepts and design criteria to achieve optimum mutual adjustment of man and his work. Static and dynamic forces on the human frame; response to environmental stress (heat, vibration, noise); vigilance and fatigue; and man-machine systems are considered. 1 unit. Prerequisite: Consent of instructor. HERTIG, JOHNSON.

306. Quantitative Methods in Ergonomics. Same as Industrial Engineering 306. Laboratory problems and discussion on measurements of the physical and mental capacities and limitations of human beings in relationship to the stresses and demands of working environment. Students become familiar with techniques and tools such as assessment of human energy expenditures on an industrial job, use of seating research chair; high speed and time lapse photography. Student teams select about six problems from a list of topics, or they may develop problems of special interest to the team. 1 unit. Prerequisite: Physiology or Industrial Engineering 305. HERTIG, JOHNSON.

312. Endocrinology. Same as Zoology 312. The glands of internal secretion with

special reference to the vertebrates. ¾ unit. Prerequisite: Physiology 301 or a course in biochemistry; consent of instructor. GORSKI.

313. **Experimental Endocrinology.** Same as Zoology 313. Laboratory techniques and project in endocrinology. ½ unit. Prerequisite: Credit or registration in Physiology or Zoology 312; consent of instructor. GORSKI.

331. **General Radiobiology.** Responses of multicellular organisms, cells, and macromolecules to ionizing radiations. Lectures, student reports, and discussions. 1 unit. Prerequisite: One year each of mathematics, physics, chemistry, and biology. DUCOFF.

369. **Introduction to Human Ecology.** Same as Anthropology, Geography, Health Education, Psychology, Sociology, Veterinary Medical Science, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations, and physiological, psychological, and sociological adjustments to environment, regulation of populations, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology; one year of anthropology, geography, geology, or sociology. SHIMKIN, STAFF.

374. **Problems in Human Ecology.** Same as Anthropology, Geography, Health Education, Psychology, Sociology, and Veterinary Medical Science 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multi-disciplinary studies of selected current problems. 1 unit. Prerequisite: Anthropology, Geography, Health Education, Physiology, Psychology, Sociology, or Zoology 369. LEVINE, STAFF.

Biophysics

COURSES FOR GRADUATES

401. **Advanced Biophysics, I.** Topics from electrobiology, muscle biophysics, and physical properties of biological media. 1 unit. Prerequisite: One year of physics beyond introductory physics or equivalent; calculus; physical chemistry; or consent of instructor.

402. **Advanced Biophysics, II.** Photobiology, including photosynthesis, bioluminescence, and visual reception. 1 unit. Prerequisite: One year of physics beyond introductory physics or equivalent; calculus; physical chemistry.

403. **Biophysical Techniques.** This course is designed to acquaint the student with physical methods useful in the solution of biological problems. Topics covered are bioelectric measurements, including basic electronics; optical methods, including microsocopy, spectrophotometry, and measurement of action spectra; use of high energy radiations; tracer techniques; acoustical techniques. ½ or 1 unit. Prerequisite: Credit or registration in Biophysics 402, or consent of instructor. DUNN, MATSUMOTO.

410. **Special Topics in Biophysics.** An advanced course on some topic of interest in biophysics, such as electrobiology, radiation biology, photobiology, bioacoustics, or the physics of muscular contraction. ½ to 1 unit. Prerequisite: Biophysics 401 or equivalent; Biophysics 402 and 403.

411. **Seminar.** Survey of the literature in one area of biophysics, with special emphasis on student reports. ½ unit. Prerequisite: Enrollment in the biophysics program or consent of instructor.

436. **Problems of Cybernetics.** Same as Communications 436 and Electrical Engineering 474. The study of brain-like processes in complex dynamic systems with

emphasis on unsolved problems, current developments, and opportunities for research. 1 unit. Prerequisite: Consent of instructor. ASHBY.

463. Radioisotopes in Biological Research: Principles and Practice. See Veterinary Medical Science 463. ¾ unit. Prerequisite: Quantitative chemistry; one year each of mathematics, physics, biology, and/or consent of instructor.

491. Individual Topics. For graduate students who wish to study individual problems or topics not assigned in other courses. ½ to 2 units. Prerequisite: Consent of instructor. STAFF.

499. Thesis Research. Research may be conducted in one of the areas listed below, subject to approval of the staff member concerned and the department in which the research is to be done. 0 to 4 units.

(a) **Bioacoustics.** DUNN.
(b) **Cellular Physiology.** BUETOW.
(c) **Electrobiology.** PROSSER.
(d) **Photosynthesis.** GOVINDJEE, SYBESMA.
(e) **Microbiology.** SPIEGELMAN, WOESE.
(f) **Physics of Muscular Contraction.**
(g) **Radiobiology.** DUCOFF.
(h) **Information Theory and Cybernetics.** ASHBY, VON FOERSTER.
(i) **Ion Transport and Permeability.**
(j) **Mechanical Properties of Tissues.** GILMAN.
(k) **Vascular Dynamics.** KIRK.
(l) **Central Nervous System.** ADES.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Introduction to Biophysics. A review of the field of biophysics designed to introduce the student to the types of biological problems currently under investigation in biophysical laboratories. ¾ unit. Prerequisite: Eight hours of physics or enrollment in the graduate biophysics program.

312. Introduction to Radiobiology. Nature and mechanisms of the biological consequences of low dose and chronic irradiation. Intended primarily for students in engineering and physical sciences. ½ unit. Prerequisite: Mathematics 142 or 143; eight hours of physics; consent of instructor. DUCOFF.

Zoology

The Department of Zoology offers work leading to the degrees of Master of Science and Doctor of Philosophy. Several areas of specialization are available.

The grade-point average for admission is 4.0. Applicants with grade-point averages below 4.0 but above 3.75 are considered on an individual basis. Applicants should have completed twenty-five hours of biology, three semesters of college chemistry including organic, two semesters of college mathematics including analytic geometry, and two semesters of physics, or equivalent. Knowledge of a foreign language is necessary and the following are recommended: French, German, Russian; Latin and Greek also are helpful.

The Master of Science requires eight units of graduate credit. Students are required to complete a thesis (Zoology 499), or a research report (Zoology 490), and, at the end of the program, complete a successful oral examination.

Admission to advanced standing requires the master's degree or the equivalent, a 4.0 grade-point average in non-thesis biology courses, and presupposes that the minimum science requirements specified for the master's degree have been met. One course in statistics is required. Quantitative chemistry, calculus, biochemistry, and other courses may be recommended by the adviser or doctoral committee. All

inquiries concerning zoology graduate programs, assistantships, fellowships, and admission should be addressed to the department office, 287 Morrill Hall (not to the Graduate College or the Office of Admissions and Records).

Graduate students in other departments who choose zoology as a minor must have had at least one year of undergraduate work in zoology.

GRADUATE FACULTY

Professors: R. L. METCALF (Head of Department), E. M. BANKS, G. W. BENNETT, B. V. HALL, J. HIRSCH, D. F. HOFFMEISTER, L. INGLE, S. C. KENDEIGH, J. B. KITZMILLER, F. J. KRUIDENIER, N. D. LEVINE, A. V. NALBANDOV, D. L. NANNEY, C. L. PROSSER, G. C. SANDERSON, P. H. SILVERMAN, H. M. SMITH, P. W. SMITH, R. L. WATTERSON.

Associate Professors: A. W. GHENT, J. E. HEATH, M. R. LEE, M. R. MATTESON, H. H. SHOEMAKER.

Assistant Professors: NELDA E. ALGER, E. H. BROWN, R. DAVENPORT, P. S. DAWSON, D. C. EADES, T. H. FRAZZETTA, M. SALMON, E. B. SMALL, D. C. SWEENEY, MARY F. WILLSON.

COURSES FOR GRADUATES

402. Molecular Genetics. See Microbiology 402. ¾ unit. Prerequisite: Microbiology 330 or equivalent. ATWOOD, SPIEGELMAN, WOESE.

405. Microbiological Genetics. See Microbiology 405. ¾ unit. Prerequisite: Microbiology 330; mathematics through calculus, or consent of instructor. ATWOOD, NANNEY, SPIEGELMAN.

406. Physiology of Reproduction. Same as Animal Science 406. Comparative physiology of reproduction and endocrinology of domestic and laboratory animals; fertility and sterility. Lectures and laboratory. 1 unit. NALBANDOV.

407. Evolutionary Theory. Genetic, systematic, ecological, and zoogeographical concepts as related to the process of evolution. 1 unit. Prerequisite: One course in genetics; consent of instructor.

408. Laboratory Methods in Physiology of Reproduction. Same as Animal Science 408. ½ to 1 unit. Prerequisite: Consent of instructor. NALBANDOV.

410. Theoretical Population Biology. A detailed examination of structure and process in population biology integrating population ecology and genetics and emphasizing theoretical concepts, quantitative relationships, and recent developments. 1 unit. Prerequisite: Calculus; credit or registration in Biology 311; consent of instructor. Statistics is highly recommended.

412. Advanced Endocrinology. See Physiology 412. Course may be repeated for credit not to exceed a total of two units. ½ unit. Prerequisite: Physiology 312; consent of instructor. GORSKI, NALBANDOV.

418. Advanced Protozoology. Advanced consideration of selected topics, with emphasis on laboratory practice in modern methods and techniques of studying both free-living and parasitic protozoa: collecting, culturing, and staining of representative forms. 1 unit. Offered in 1970-1971 and in alternate years. Prerequisite: Zoology 318 or equivalent. SMALL.

419. Topics in Experimental Protozoology. Consideration of the advantageous employment of protozoa in modern researches concerned with basic biological problems; selected experimental topics covered by lectures, demonstrations, discussions, reports, and readings. ½ or 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Consent of instructor. SMALL.

420. Experimental Invertebrate Zoology. Study of current research problems and practice in the experimental methods used in the area of invertebrate zoology. 1 unit. Prerequisite: Zoology 320 or equivalent; consent of instructor. SWEENEY.

421. Cytogenetics. See Botany 421. 1 unit. Prerequisite: Biology 210, or Microbiology 330, or consent of instructor. STEFFENSEN.

422. Advanced Parasitology. Advanced study of modern methods in helminthology. 1 unit. Prerequisite: Zoology 321 or equivalent. KRUIDENIER.

424. Invertebrate Taxonomy. Individual problems in taxonomy of invertebrates. 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Zoology 304. MATTESON.

425. Experimental Parasitology. Same as Veterinary Medical Science 425. A broadly based consideration of the relation of parasites to their hosts and to their environments, and of the factors which influence these relationships. 1 unit. Prerequisite: A laboratory course in parasitology or protozoology; organic chemistry; Chemistry 350; biochemistry and statistics are recommended. LEVINE, SILVERMAN.

433. Topics in Developmental Biology. A study of initial differences in developing systems and interactions leading to more complex differences. May be elected in successive years. ¼ unit. Maximum credit for master's candidates, one unit; for doctoral candidates, three units. Prerequisite: Zoology 367. WATTERSON.

441. Advanced Comparative Physiology. See Physiology 441. ½ unit. Prerequisite: Consent of instructor. STAFF.

442. Advanced Comparative Physiology Laboratory. See Physiology 442. 1 unit. Prerequisite: Physiology 402, 403, and 404; credit or registration in Physiology 441.

444. Concepts in Ethology. Group discussion of problems such as stimulus filtering, spontaneity, and stereotyped motor patterns, with a new topic each semester. ½ unit. Prerequisite: Zoology 346. BANKS.

445. Seminar in Fish and Wildlife Ecology. Modern ecological principles and concepts to specific problems in fisheries and wildlife. Offered in 1969-1970 and in alternate years. ½ unit. Prerequisite: Zoology 342 or 345, or equivalent.

446. Physiological Ecology. Physiological adjustments and responses of organisms to their environment. 1 unit. KENDEIGH.

447. Advanced Ethology. Designed to provide experience with the current technology of animal behavior study, including sound spectrographic analysis, cinematographic time and motion study, and other procedures. 1 unit. Prerequisite: Consent of instructor. BANKS, SALMON.

451. Advanced Cellular Physiology. See Physiology 451. ½ unit. Prerequisite: Consent of instructor. STAFF.

467. Experimental Embryology. 1 unit. Prerequisite: Zoology 367. WATTERSON.

490. Individual Research. For master's degree candidates who elect to write a research report rather than a thesis. No more than three units may be included in the master's degree program. ½ to 3 units. Prerequisite: Consent of adviser. STAFF.

499. Thesis Research. 0 to 4 units. Work in the following fields is offered for students registered in Zoology 499:

Anatomy, Physiology, and General Classification of Vertebrates: Vertebrate Anatomy, H. SMITH; Endocrinology, HALL, NALBANDOV; Functional Anatomy,

FRAZZETTA; Histology, DAVENPORT; Ultrastructure, HALL; Vertebrate Physiology, HEATH, PROSSER.

Anatomy, Physiology, and General Classification of Invertebrates: Helminthology. KRUIDENIER, LEVINE, SILVERMAN; Invertebrate Zoology, MATTESON, SWEENEY; Invertebrate Physiology, PROSSER, SWEENEY; Parasitology, ALGER, KRUIDENIER, SILVERMAN; Protozoology, SMALL.

Embryology and Basic Knowledge of Cells and Tissues: Cytology, DAVENPORT; Embryology and Regeneration, DAVENPORT, WATTERSON; Toxicology, INGLE.

Principles of Ecology, Principles of Taxonomy, Natural History: Ecology, GHENT, KENDEIGH, WILLSON; Ethology, BANKS, HIRSCH, SALMON; Herpetology, H. SMITH; Ichthyology, SHOEMAKER, P. SMITH; Limnology, BENNETT, MATTESON; Mammalogy, HOFFMEISTER, LEE; Ornithology, KENDEIGH, WILLSON; Taxonomy, EADES; Wildlife Management, KENDEIGH, SANDERSON, SHOEMAKER.

Genetics and Evolution: Genetics and Evolution, BROWN, DAWSON, KITZMILLER, NANNEY; Vertebrate Phylogeny and Paleontology, FRAZZETTA.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. General Seminar. For members of the staff and graduate students. Required of all graduate students, but also open to seniors whose major is zoology. No credit. Attention is called to the following special clubs and seminars, some of which are interdepartmental: Animal Ecology Club, Genetics Seminar, Endocrinology Seminar, and Parasitology-Protozoology Seminar.

303. Individual Topics. For those who wish to study individual problems. Graduate students may register for topics involving individual work not assigned in other courses. Laboratory, conferences, and readings. ½ or 1 unit. Prerequisite: Two years of zoology or consent of department. STAFF.

304. Field and Systematic Zoology. Collection, preservation, and identification of lower vertebrates and land and fresh-water invertebrates; habits and life histories of selected forms. 1 unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent; consent of instructor. MATTESON.

312. Endocrinology. See Physiology 312. ¾ unit. Prerequisite: Physiology 301 or a course in biochemistry; consent of instructor. GORSKI.

313. Experimental Endocrinology. See Physiology 313. ½ unit. Prerequisite: Credit or registration in Physiology or Zoology 312; consent of instructor. GORSKI.

318. Protozoology. Basic treatment of the morphology, physiology, and systematics of the protozoa; also consideration of their evolution, ecology, morphogenesis, sexual phenomena, genetics, and parasitism, with life histories of selected free-living and parasitic forms. 1 unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent. SMALL.

320. Invertebrate Zoology. Invertebrates; structure and development. Application of biological principles. Specific and comparative morphology of the invertebrates; coordination of structure and function, origin, development, and life histories. 1 unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent. SWEENEY.

321. Parasitology. Worm parasites, life cycles, morphology, taxonomy, environmental relations. Lecture, laboratory, technique, readings, quiz, demonstrations, and problems. 1 unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent. KRUIDENIER.

324. Vertebrate Paleontology. Same as Geology 324. Phylogeny, morphology, and ecology of the fossil vertebrates. Lecture, laboratory, and field trips. ½ unit.

Offered in 1970-1971 and in alternate years. Prerequisite: Zoology 232 or Geology 102.

330. **Practical Microtechnique.** An introduction to microscopy, microphotography, and histological technique. ½ unit. Prerequisite: Histology or embryology and consent of instructor. ALGER, KRUIDENIER.

331. **Experimental Cytology.** See Botany 331. 1 unit. Prerequisite: Biology 151, 210, or 251; consent of instructor. DAVENPORT, STEFFENSEN.

332. **Advanced Vertebrate Zoology.** Vertebrate morphology; comparative anatomy, evolution, and function of vertebrate organ systems, with special emphasis on the evolution, anatomy, and function of the skeletal and nervous systems. Lectures and laboratory. 1 unit. Prerequisite: Zoology 232. FRAZZETTA.

333. **Vertebrate Embryology.** The development of the vertebrate body and its organs. 1 unit. Prerequisite: Biology 111 or 251, or equivalent. WATTERSON.

335. **Ornithology.** Structure, functions, environmental relations, habits, life history, and identification of birds. Laboratory during the first eight weeks and field trips during the last eight weeks of the semester. ½ unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent. KENDEIGH, WILLSON.

336. **Mammalogy.** Classification, distribution, life history, evolution, and identification of mammals. Lecture, laboratory, and field work. 1 unit. Prerequisite: Zoology 232. HOFFMEISTER, LEE.

337. **Ichthyology.** Classification, structure, evolution, distribution, and life history of fish. Lectures, laboratory, and field work. ½ unit. Prerequisite: Zoology 232. SHOEMAKER.

338. **Herpetology.** Classification, distribution, life history, and identification of reptiles and amphibians, particularly those of the United States. Lectures, laboratory, and field work. ½ unit. Offered in 1970-1971 and in alternate years. Prerequisite: Zoology 232.

340. **Natural History of the Vertebrates.** Identification, distribution, adaptation, food, ecology, and life history with emphasis on vertebrates of Illinois. Lectures, laboratory, and field work. 1 unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent; consent of instructor. WILLSON.

341. **Field Ecology.** During spring vacation, study of biotic communities, mammals, birds, reptiles, amphibia, fishes, and invertebrates in various sections of North America. Outdoor camping and cooking. Transportation in University cars. ¼ unit. Prerequisite: Credit or registration in one of the following: Zoology 304, 335, 336, 337, 338, 340, 345; consent of instructor. KENDEIGH, SHOEMAKER.

342. **Wildlife Management and Conservation.** Size and measurement of animal populations, factors affecting reproduction and mortality, life history, management policies for fish, mammals, and birds. ½ unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent. SHOEMAKER.

343. **Limnology.** Fresh-water biology. Study of the lake, pond, and river with emphasis on the physical environment as well as on the plants and animals which live in fresh water. Lectures, discussions, laboratory, and field work. 1 unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent; consent of instructor. MATTESON.

345. **Animal Ecology.** Composition, dynamic development, and distribution of biotic communities. ¾ or 1 unit. Students enrolling for three-fourths unit are required to do field work on six Saturdays (recommended for those also enrolled in Zoology 342); those enrolling for one unit are required to do field or laboratory work every Saturday, including one weekend camping trip;

estimated expense, $8.50. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent. KENDEIGH.

346. Ethology. Same as Animal Science 346. The behavior of animals as interpreted through comparative studies and experimentation. Lecture, ½ unit; lecture and laboratory, 1 unit. Prerequisite: One year of 300-level courses in zoology, physiology, or psychology; consent of instructor for laboratory enrollment.

361. Individual and Group Behavior of Honey Bees. Same as Horticulture 361. ½ unit. Prerequisite: One semester of entomology or zoology. JAYCOX.

367. Analysis of Development. Advanced study of basic problems in developmental biology. Major emphasis is placed on interactions at molecular, fine structural, and cellular levels, and the genetic and metabolic mechanisms by which these interactions are controlled in plants and animals. Theories of differentiation are critically examined in the light of recent research. Lectures, discussions, outside readings, and student reports. ¾ unit. Prerequisite: Biology 211 or Zoology 333; Biology 210; organic chemistry.

369. Introduction to Human Ecology. Same as Anthropology, Geography, Health Education, Physiology, Psychology, Sociology, and Veterinary Medical Science 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations, and physiological, psychological, and sociological adjustments to environment, regulation of populations, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology; one year of anthropology, geography, geology, or sociology. KENDEIGH, SHIMKIN, STAFF.

LINGUISTICS

(Including Arabic and Hindi)

The Department of Linguistics offers a graduate program leading to the Master of Arts and Doctor of Philosophy. The following fields of linguistics are available for concentration: descriptive linguistics, historical linguistics, applied linguistics, interdisciplinary study in psycholinguistics, ethnolinguistics, experimental phonetics, and mathematical linguistics.

Undergraduate preparation for the study of linguistics should include the equivalent of at least three years of foreign language experience; for historical linguistics, a broad background in the humanities and social studies; and for descriptive linguistics, the equivalent of good undergraduate training in mathematics and the sciences. Students applying for admission should have at least a 4.0 grade-point average for that portion of the work which represents the last sixty hours earned toward the bachelor's degree. Applications of students with a grade-point average between 3.5 and 3.99 are considered on an individual basis.

Master of Arts. Candidates for this degree must earn eight units, of which six units must be in linguistics and must include Linguistics 302, 340, 401, and 402.

In addition to fulfilling the general requirements of the Graduate College, the student must pass the reading examination in one foreign language, pass the comprehensive qualifying examination in general linguistics (and special subjects, if appropriate), and must submit a satisfactory master's essay to the department; admission to the qualifying examination is contingent upon success in the language examination.

Doctor of Philosophy. Admission to candidacy for this degree normally requires a grade-point average of 4.5 or better for all graduate work in linguistics. Candidates for this degree must complete at least twenty-four units of graduate work, or sixteen units beyond the master's degree. The minimum twenty-four units must

include the course requirements listed above for the master's degree (or their equivalent), Linguistics 404, advanced work in both phonology and syntax, courses in the structure of non-Western languages, and eight units of Linguistics 499.

Students are encouraged to attend at least one summer session of the Linguistic Institute of the Linguistic Society of America. Up to four units of credit granted by the host university under this program may be transferred. Students of descriptive linguistics also are required to establish a vested interest and a firm basic foundation in some particular language or language family at as early a point as possible in their graduate career.

Candidates must demonstrate proficiency in two languages other than English and must pass the comprehensive qualifying examination (mentioned above for the master's degree), preferably after the first year of graduate work, unless they have already qualified for the Master of Arts in Linguistics.

Linguistically oriented courses in related departments may be counted toward the major if approved by the adviser. The head of the department acts as general adviser to each student until he selects his field of concentration, at which time he comes under the guidance of an adviser in his special area.

GRADUATE FACULTY

Professors: J. H. D. Allen, J. B. Casagrande, C. L. Dawson, H. R. Kahane, R. B. Lees, F. K. Lehman, M. A. Morínigo, C. E. Osgood.

Associate Professors: B. Kachru (Head of Department), Katharine O. Aston, F. M. Jenkins, Yamuna Kachru, H. S. Maclay.

Assistant Professors: C.-W. Kim, J. Yegerlehner, W. R. Zemlin.

Linguistics

COURSES FOR GRADUATES

401. Syntax. Critique of traditional and contemporary theories of syntactic structure; systematic introduction to transformational grammar. 1 unit. Prerequisite: Linguistics 300 or equivalent. Geis.

402. Phonology. Examination of language-specific phonological problems with a view toward formulating a language-independent theory of phonology. 1 unit. Prerequisite: Linguistics 301 or consent of instructor. Lightner.

403. Seminar in Linguistic Analysis. Discussion of advanced topics of current interest in descriptive linguistics. 1 unit. May be repeated for credit with consent of instructor. Prerequisite: Linguistics 401. Zwicky.

404. Practicum. Classroom- and homework-solving of assorted problems in syntactic and phonological analysis of many languages. 1 unit. Prerequisite: Linguistics 401 and 402.

405. Seminar in Stylistics. A seminar designed to evaluate and discuss earlier and current linguistically motivated stylistic theories; emphasis on the theoretical and methodological problems in application of linguistics to stylistic analysis of literary texts. 1 unit. Prerequisite: Linguistics 300 or 305; consent of instructor.

407. Advanced Topics in Mathematical Linguistics. The hierachy of automata and the hierarchy of grammars; equivalence theorems and undecidability theorems; recognition procedures. 1 unit. Prerequisite: Linguistics 307 or equivalent.

408. Russian Phonology. Same as Russian 408. Synchronic examination of the phonological system of modern Russian and of its interrelation with the

syntactic and lexical systems; brief discussion of the historical development of the phonological system. 1 unit. Prerequisite: Consent of instructor. LIGHTNER.

409. **Field Methods in Linguistics.** Same as Anthropology 409. The recording and analysis of a spoken language with a native speaker of that language as an informant. 1 unit. Prerequisite: Credit or registration in Linguistics 401. LEHMAN, YEGERLEHNER.

410. **Advanced Field Methods in Linguistics.** Same as Anthropology 410. Advanced analysis of a spoken language with a native speaker of that language as an informant. 1 unit. Prerequisite: Linguistics or Anthropology 409, or equivalent. LEHMAN, YEGERLEHNER.

411. **Methods in Historical Linguistics.** Advanced analysis of genetic comparison and reconstruction, linguistic borrowing, linguistic geography, etymology, and related topics. 1 unit. Prerequisite: Linguistics 302 or 315. HOCK, KAHANE.

412. **Research Seminar in Historical Linguistics.** Research work in etymology, linguistic geography, and historical syntax. 1 unit. Prerequisite: Linguistics 411 or consent of instructor. KAHANE.

415. **Seminar in Indo-European Linguistics.** Discussion and research paper on topics in Indo-European languages, their history, origins, development, and migration. 1 unit. HOCK.

419. **Contrastive Linguistics.** Same as Rhetoric 419. A critical survey of contemporary linguistic models with special reference to their relevance in preparing contrastive analyses of languages; detailed discussion on contrastive analyses of English and selected non-Western languages at different linguistic levels. ½ or 1 unit. Prerequisite: Linguistics 300 or consent of instructor. Y. KACHRU.

420. **Linguistic Phonetics.** Principles of scientific description of the phonic aspect of language; distinctive features and phonetic alphabets; relations between phonetics and other linguistic levels; and inventory of speech sounds. 1 unit. Prerequisite: Linguistics 301 or equivalent. KIM.

421. **Seminar in Phonetic Theories.** Theories of speech production; motor theory and linguistic change; acoustical correlates of vocal-tract configurations; theories of speech perception; and a model of universal phonetics. 1 unit. Prequisite: Linguistics 301 or equivalent. KIM.

424. **Linguistics and Communication.** Same as Communications 424. The communicative function of language with emphasis on the application of linguistic theories and methods to problems in human communication. 1 unit. MACLAY.

425. **Psycholinguistics.** Same as Communications and Psychology 425. A critical survey of methods and theories in the psychological study of the communication process with emphasis upon linguistic, information-theory and learning-theory approaches, psycholinguistic analysis of language decoding and encoding, and the development and measurement of symbolic processes, including meaning. 1 unit. Prerequisite: Consent of instructor. OSGOOD.

426. **Research Seminar in Psycholinguistics.** Same as Communications and Psychology 426. Critical discussion of research problems to which psycholinguistic theories and techniques can be applied. Students taking this course are expected to plan, execute, and report an original piece of research in this area during the course. ½ or 1 unit. Prerequisite: Linguistics 425; consent of instructor. MACLAY, OSGOOD.

450. **Linguistics and the Study of Meaning.** A consideration of those aspects of

meaning which are the concern of linguistic theory. 1 unit. Prerequisite: Linguistics 300. YEGERLEHNER.

462. Introduction to Romance Linguistics. Same as French, Spanish, Italian, and Portuguese 462. Comparative and historical analysis of the Romance languages. ½ unit. Prerequisite: Four semesters of a Romance language or Latin, or equivalent. KAHANE.

473. Seminar in Phonetics. Same as Speech 473. Advanced study in phonetic theory and noninstrumental phonetic investigation. 1 unit. Prerequisite: Consent of instructor. ZEMLIN.

475. Experimental Phonetics, I. Same as Speech 475. Theoretical consideration of speech as motor behavior, with special reference to physiological investigations of normal respiration, phonation, and articulation. Survey of the experimental literature. 1 unit. Prerequisite: Consent of instructor. ZEMLIN.

476. Experimental Phonetics, II. Same as Speech 476. Theoretical consideration of speech as an acoustical phenomenon, with special reference to acoustical investigations of voice and speech sounds. Survey of the experimental literature. 1 unit. Prerequisite: Consent of instructor. ZEMLIN.

477. Measurement of Speech, I. Same as Speech 477. Principles and methods of measuring speech action. Special action recorders and transducers; techniques of analysis; problems of experimental design. Laboratory experimentation. 1 unit. Prerequisite: Consent of instructor; credit or registration in Linguistics 475. ZEMLIN.

478. Measurement of Speech, II. Same as Speech 478. Principles and methods of measuring the acoustical phenomena of speech. Oscillographic measurement of vocal variables; special instruments and media for automatic graphic recording; analysis of data; problems of experimental design. Laboratory experimentation. 1 unit. Prerequisite: Consent of instructor; credit or registration in Linguistics 476. ZEMLIN.

481. Topics in Syntactic Theory. Investigation of syntactic universals; recent developments in the theory of syntax. 1 unit. Prerequisite: Linguistics 317, 387, or 401; consent of instructor. GEIS.

482. Topics in Phonological Theory. Continuation of Linguistics 402. Special topics and individual papers are assigned. 1 unit. Prerequisite: Linguistics 402 or equivalent. LIGHTNER.

490. Special Topics in Linguistics. Individual studies in the areas of linguistics not covered by regular course offerings. ½ to 2 units.

499. Thesis Research. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Introduction to Linguistics. Same as Anthropology 300. An introduction to the science of descriptive linguistics. ½ unit. Prerequisite: Fulfillment of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. STAFF.

301. Introduction to General Phonetics. An introduction to the main branches of general phonetics and phonological theory; emphasis on analysis of non-Western languages and research techniques. ½ unit. KIM.

302. Comparative Linguistics. An introduction to the historical aspects of language. ½ unit. Prerequisite: Fulfillment of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. KAHANE.

303. Non-Western Linguistic Structures. Intensive study of linguistic structure of a selected non-Western language. May be repeated for credit with consent of instructor. 1 unit.

305. Introduction to Applied Linguistics. An introduction to the applications of general linguistic theory to the specific fields of stylistics, theory of translation, contrastive analyses, and the teaching and learning of foreign (and second) languages. Practical assignment work. ¾ unit. Prerequisite: Consent of instructor. B. KACHRU.

307. Introduction to Mathematical Linguistics. Same as Anthropology 307. Principles of set theory, logic and formal systems, group theory, and automata theory; introduction to the formal theory of grammars. 1 unit. Prerequisite: Linguistics 300.

308. Comparative Grammar of Greek and Latin. See Greek 308. ½ unit. Prerequisite: Latin 202 or equivalent; credit or registration in Greek 202.

315. Introduction to Indo-European Linguistics. Introductory survey of Indo-European languages and their mutual relations; exemplification of methods of reconstruction through examples from Indo-European languages; discussion of theories about the originial home, culture, and society of the Indo-Europeans; introductory presentation of the sound laws of the major Indo-European languages and of the overall structure of Indo-European morphology. 1 unit. Prerequisite: Fulfillment of the language requirement of the College of Liberal Arts and Sciences. HOCK.

316. Structure of the French Language. Same as French 316. A general survey of the linguistic structure of modern standard French, including phonology, morphology, and syntax. Emphasis is on the differences between its spoken and written forms. ¾ unit. Prerequisite: French 313 or equivalent training in phonetics. JENKINS.

317. Languages of the World. Same as Anthropology 317. A survey of the main language families of the world from both genetic and typological points of view, with special reference to the theory of syntactic descriptions. ½ or 1 unit. Prerequisite: Linguistics 300 or consent of instructor. YEGERLEHNER.

325. Introduction to Pyscholinguistics. Same as Communications 325. An introductory survey of psychological and linguistic approaches to the study of communication. 1 unit. Prerequisite: An introductory course in linguistics or in psychology. MACLAY.

338. Philosophies of Language. Same as Philosophy 338. A study of the development of philosophical problems about language and the treatment of them from antiquity through the nineteenth century. ¾ or 1 unit. Prerequisite: One course in philosophy. FABER.

340. History of Linguistics. Survey of linguistic theories from ancient to modern times; special emphasis on comparative grammar and the development of structural linguistics; extended discussion of at least one other period. 1 unit. Prerequisite: Linguistics 300 or equivalent. B. KACHRU, ZWICKY.

350. Sociolinguistics. A critical study of the sociologically oriented general linguistic theories with special reference to language varieties, language attitudes, language diversity, language standardization, linguistics geography, language and political roles (language loyalty). Emphasis on research methodology and techniques. Concentration on South Asia. ½ or 1 unit. Prerequisite: Linguistics 300 or consent of instructor. B. KACHRU.

351. Area Linguistics. Introduction to area classification, linguistic convergence, and borrowing; the Southeast Asia *Sprachbund;* phonological, morphological, and syntactic convergence. 1 unit. Prerequisite: Linguistics 300. LEHMAN.

367. Introduction to Germanic Linguistics. Same as Germanic 367. A comparative and historical survey of the Germanic languages. ½ unit. Prerequisite: Completion of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. Some knowledge of German desirable.

370. Language, Culture, and Society. Same as Anthropology and Communications 370. An examination of the social and cultural functions of language, with particular emphasis on the application of linguistic methods and findings to selected problems in the social sciences. ½ or 1 unit. CASAGRANDE.

375. Speech Science, I. Same as Speech 375. Introduction to the anatomical and physiological characteristics of the normal speech and hearing mechanisms, and to the fundamental acoustics of speech. ½ unit. Prerequisite: Speech 109 or 301 or consent of instructor. ZEMLIN.

376. Speech Science, II. Same as Speech 376. Consideration of the physiology of the speaking act, the acoustical characteristics of voice and speech sounds, and the hearing of speech. ½ unit. Prerequisite: Speech 375 or consent of instructor. ZEMLIN.

380. Introduction to Slavic Linguistics. Same as Slavic 380. Changes in phonology and morphology from Indo-European to Common Slavic; geographical distribution of Slavic languages and dialects, prehistory and early history of the Slavs, and Balto-Slavic linguistic relationships. ¾ unit. DAWSON.

382. Introduction to Sanskrit Linguistics, I. The sounds and alphabet of Sanskrit; introduction to grammar, with drill and readings; sandhi rules; reading: Nala and Damayanti. 1 unit. Prerequisite: Linguistics 300; consent of instructor.

383. Introduction to Sanskrit Linguistics, II. Further grammar and reading; consideration of Sanskrit from one or more of the following points of view: (1) comparative Indo-European linguistics, (2) Indology, (3) Paninian linguistics, (4) Western linguistic theories, (5) transformational-generative grammar. 1 unit. Prerequisite: Linguistics 382.

387. The Structure of English. Same as English 387. Critical evaluation of traditional and structuralist grammatical descriptions; introduction to transformational grammatical studies; detailed survey of a transformational syntax of English; brief introduction to generative phonology and morphophonemic analysis of English, especially stress. ¾ unit. GEIS.

388. Linguistics in Language Learning, I. Same as Rhetoric 388. The application of linguistic methods in the learning of a second language, with special emphasis on the learning of English. ¾ unit. Prerequisite: Two years of a foreign language, or equivalent; consent of instructor. ASTON.

389. Linguistics in Language Learning, II. Same as Rhetoric 389. Applied linguistics in teaching and learning English as a second language, with special emphasis on the application of some principles of psycholinguistics, sociolinguistics, and ethnolinguistics along with the related disciplines of education, psychology, and anthropology to structured teaching/learning situations. ¾ unit. Prerequisite: Linguistics 388. ASTON.

Arabic

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. Intermediate Arabic, I. First term of second year of work in the Arabic language, with drill for more advanced conversational fluency; introduction to a greater variety of styles and levels of discourse and usage, increasing study of the written language, and more formal grammar. ½ unit. Prerequisite: Arabic 202 or equivalent. ABDO.

304. **Intermediate Arabic, II.** Concentration upon ability to engage in reasonably fluent discourse in Arabic, on comprehensive knowledge of formal grammar, and on ability to read ordinary written Arabic. ½ unit. Prerequisite: Arabic 303 or equivalent. ABDO.

305. **Advanced Arabic, I.** Reading selections from literary works; selections from political, social, historical, and economic writings. ½ unit. Prerequisite: Arabic 304 or equivalent. ABDO.

306. **Advanced Arabic, II.** A continuation of Arabic 305. Further reading in literary sources as well as in history, economics, and politics. ½ unit. Prerequisite: Arabic 305 or equivalent. ABDO.

Hindi

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. **Intermediate Hindi, I.** First term of second year of work in the Hindi language, with drill for more advanced conversational fluency; introduction of a greater variety of styles and levels of discourse and usage, increasing study of the written language, and more formal grammar. ½ unit. Prerequisite: Hindi 202 or equivalent. SUBBARAO.

304. **Intermediate Hindi, II.** Concentration upon ability to engage in reasonably fluent discourse in Hindi, on comprehensive knowledge of formal grammar, and on ability to read ordinary texts in Hindi. ½ unit. Prerequisite: Hindi 303 or equivalent. SUBBARAO.

305. **Advanced Hindi, I.** A course for advanced knowledge of spoken and written Hindi. All students are required to work at least one hour every week with a native informant and/or in the language laboratory. ½ unit. Prerequisite: Hindi 304 or consent of instructor. SUBBARAO, Y. KACHRU.

306. **Advanced Hindi, II.** A course for advanced knowledge of spoken and written Hindi with emphasis on modern Hindi literature and language. All students are required to work at least one hour every week with a native informant and/or in the language laboratory. ½ unit. Prerequisite: Hindi 305 or consent of instructor. SUBBARO, Y. KACHRU.

MANAGEMENT

See Business Administration, page 103.

MARKETING

See Business Administration, page 103.

MATHEMATICS

(Including Statistics)

The Department of Mathematics offers graduate work leading to the Master of Arts or Master of Science in Mathematics and Doctor of Philosophy in Mathematics, Master of Science in the Teaching of Mathematics, and Master of Arts or Master of Science in Statistics and Doctor of Philosophy in Statistics. For information concerning applied mathematics, see page 307.

MATHEMATICS

For admission a beginning graduate student must have a grade-point average of 3.75. Applications of students with grade-point averages below 3.75 but above 3.5 are considered on an individual basis.

A student should have had twenty-six hours of undergraduate work in mathematics besides the usual freshman courses in algebra, trigonometry, and analytic geometry, including a one-year course in calculus and at least nine semester hours of more advanced work in one or more of the fields of algebra, geometry, topology, analysis, number theory, and numerical analysis. The last requirement refers to courses equivalent to Mathematics 317-318, 327-328, 332, 347-348, 353-354, and 387.

Master of Arts or Master of Science in Mathematics. The departmental requirements for the master's degree in mathematics are as follows: of the eight units required for the degree, at least six must be in mathematics, at least three of them in approved 400-level courses. Mathematics 347-348 and at least one other basic year sequence at or above the intermediate level, normally one of the sequences 317-318, 327-328, 332-435, should be included. More than one-half of this last requirement should be fulfilled in previous undergraduate work. A master's thesis is not required.

Master of Science in the Teaching of Mathematics. Candidates for the Master of Science in the Teaching of Mathematics must earn four units in mathematics, two units in education, and two units in electives. To meet requirements for this degree, candidates must have completed, either as prerequisites to admission or as part of their graduate program, all of the following courses or their equivalents: Mathematics 302, 303, 306, 307, 317, 318, 343, 347. A student who has not completed at least two of these courses as an undergraduate can not expect to qualify for the Master of Science in the Teaching of Mathematics in one year. Required courses in education are History and Philosophy of Education 304 and 305 and Educational Psychology 311 and 312. The electives may be in mathematics, in education, or, in exceptional cases, in other fields. Students applying for admission must have a grade-point average of 3.75. Applications of students with grade-point averages below 3.75 but above 3.5 are considered on an individual basis. The adviser for this degree is Professor Wilson M. Zaring, 303 Altgeld Hall. See pages 38 and 39.

Doctor of Philosophy in Mathematics. The departmental requirements for the Doctor of Philosophy are as follows: the major subject is to be chosen from algebra, analysis, applied mathematics, geometry, logic, probability and statistics, topology; the student must choose two internal minors from this list, or one internal minor and one outside minor, or a full outside minor; the choice of the outside minor, whether split or full, must have the approval of the Department of Mathematics.

Before taking the preliminary examination, the student must present sixteen units or its equivalent with the approval of the department. Of these units, at least ten units must be in 400-level mathematics courses, except for a student with a full outside minor, eight such units suffice. The preliminary examination in mathematics is based on the student's major and internal minor subjects, but is also intended to test the student's breadth of knowledge in mathematics. In the case of a full or split outside minor, the minor department may give an independent examination, if it so chooses, or may establish other criteria for evaluation of the student's ability.

At least two 400-level courses are required for each internal minor. The following mathematics courses are typical of those which may be used to satisfy major or minor requirements, and are listed by fields. It is left to the discretion of the department, however, to decide which courses may be chosen to fulfill such requirements.

Algebra: 401-408, 415, 416, 422.

Analysis: 440-447, 449, 453-456, 468, 469, 487.

Applied Mathematics: 444, 455-460, 461, 463, 465, 487-489.

Geometry: 408, 420, 422-426, 428.
Logic: 410-413, 416.
Probability and Statistics: 451, 452, 461, 463, 470, 473, 474, 478.
Topology: 431-435, 438, 439.
Furthermore, Mathematics 490 and 493 may be used for major or minor requirements in all areas, subject to the approval of the department.

Every student who intends to work toward a degree of Doctor of Philosophy in Mathematics is expected to take a written qualifying examination within one year after completing his requirements for the master's degree; this examination is based on topics covered in Mathematics 317, 318, 347, 348. Furthermore, each student is expected to take the preliminary examination within one year after completing sixteen units of graduate work. The department may relax the requirements in the preceding two sentences, if special circumstances so warrant.

The language requirement must be met by demonstrating a reading proficiency in any two of the following three languages: French, German, and Russian.

STATISTICS

This program of study is developed for those who wish to concentrate on research in the theory of statistics, and to provide training in the theory and practice of statistical inference from quantitative data. It also provides an appropriate minor for those who wish to develop competence in an area of application of statistics, such as agronomy, biology, chemistry, economics, education, geology, physics, or psychology. The program is administered by the Department of Mathematics with the help of a small interdepartmental advisory committee.

For admission to full standing, a beginning graduate student must have a grade-point average of not less than 3.75. Applications of students with grade-point averages below 3.75 but above 3.5 are considered on an individual basis. The completion of a thorough course in calculus is also a prerequisite to admission. A course in advanced calculus, while not required, is helpful. Students are admitted on limited status.

Master of Arts or Master of Science in Statistics. A candidate for the master's degree in statistics, in addition to satisfying the general requirements of the Graduate College, must complete the following courses: (1) Mathematics 315 and 347, or equivalent; (2) four units of statistics of which at least two must be 400 courses; (3) two units in mathematics or an area of application; (4) two units of electives approved by the adviser.

However, so long as a student fulfills the standard requirements for graduate degrees (see pages 32 to 39), he can complete some of these course requirements as an undergraduate, or by outside reading, or by any other means approved by the Department of Mathematics.

Doctor of Philosophy in Statistics. The thesis for the Doctor of Philosophy must show capacity for important original contributions to one or more of the following: development of new statistical ideas and methods; improvement of applications of statistical methods; and new uses of statistical methods in some field of application. The work of individual students is supervised by one adviser if the courses referred to as electives in the following are taken in general statistics; otherwise by two advisers, one representing the field of general statistics and one representing mathematics or a field of application.

A candidate for the Doctor of Philosophy in Statistics, in addition to satisfying the general requirements of the Graduate College (note the requirement of a minor of at least two units in an area of study other than statistics or mathematics), must complete the following courses: (1) Mathematics 315, 347, or equivalent; (2) eight units of statistics of which at least four must be courses at the 400 level, selected from a list of courses prepared by the Department of Mathematics and including

all courses in statistics listed jointly by the Department of Mathematics, and areas of application; (3) four units in mathematics or an area of application, not more than two of which should emphasize training in statistics; (4) six units of electives approved by the adviser.

Candidates for a Doctor of Philosophy taking a sole minor in statistics are expected to have completed a course in calculus and are required to complete four units of work in statistics having calculus as prerequisite. Those taking a first or second minor in statistics are required to complete at least two units of work in statistics having calculus as prerequisite.

GRADUATE FACULTY

Professors: P. T. Bateman (Head of Department), R. G. Bartle, C. R. Blyth, W. W. Boone, D. L. Burkholder, S. S. Cairns, R. W. Carroll, K. T. Chen, E. C. Dade, M. M. Day, J. L. Doob, C. W. Gear, D. B. Gillies, S. I. Goldberg, J. W. Gray, W. Haken, Mary-Elizabeth Hamstrom, M. H. Heins, F. E. Hohn, P. W. Ketchum, R. G. Langebartel, H. Levy, C. W. Mendel, D. E. Muller, H. Osborn, E. T. Parker, I. Reiner, J. J. Rotman, L. A. Rubel, E. J. Scott, J. L. Selfridge, M. Suzuki, G. Takeuti, T. W. Ting, W. J. Trjitzinsky, H. E. Vaughan, J. H. Walter, R. A. Wijsman.

Associate Professors: K. I. Appel, J. W. Armstrong, R. B. Ash, S. B. Bank, I. D. Berg, E. R. Berkson, R. L. Bishop, P. G. Braunfeld, Josephine H. Chanler, W. A. Ferguson, R. L. Finney, R. M. Fossum, L. L. Helms, R. P. Jerrard, S. S. Jogdeo, F. W. Kamber, R. P. Kaufman, F. B. Knight, T. G. McLaughlin, J. Nievergelt, H. Paley, A. L. Peressini, J. W. Peters, W. Philipp, M. Rajagopalan, R. R. Rao, N. J. Rothman, Jewell E. Schubert, D. R. Sherbert, P. Tondeur, P. M. Weichsel, E. C. Weinberg, J. E. Wetzel, W. M. Zaring.

Assistant Professors: S. K. Aggarwal, J. R. Alexander, Jr., A. Babakhanian, Felice D. Bateman, Geneva G. Belford, Astrid J. Berkson, B. C. Berndt, R. Bohrer, J. W. Brown, R. F. Craggs, H. G. Diamond, L. G. Dornhoff, R. J. Faudree, Jr., G. K. Francis, W. Frascella, D. K. Friesen, G. J. Janusz, C. G. Jockusch, D. Leviatan, P. Loeb, L. R. McCulloh, C. F. Osgood, J. T. Parr, Phyllis G. Parr, N. T. Peck, Irma Reiner, D. Robinson, T. T. Robinson, K. Stolarsky, W. F. Stout, J. Uhl, Jr., K. G. Witz, P. D. Zvengrowski.

Visiting Lecturer: Gudrun Kalmbach.

COURSES FOR GRADUATES

401. Second Course in Abstract Algebra, I. The Noether isomorphism theorem for groups; permutation groups; simplicity of the alternating group; Jordan-Holder theorem; Euclidean rings; fundamental theorem of Galois theory. 1 unit. Prerequisite: Mathematics 317 and 318.

402. Second Course in Abstract Algebra, II. Wedderburn theorem on semi-simple rings; fundamental theorem of finitely generated Abelian groups (with application to canonical forms for matrices); Krull-Schmidt theorem; tensor products; exterior algebra. 1 unit. Prerequisite: Mathematics 401.

403. Theory of Rings. Ideal theory in commutative rings; structure of noncommutative rings. 1 unit. Prerequisite: Mathematics 401, 402, or equivalent.

404. Group Theory. Structure of groups, derived groups, nilpotence and solvability,

extensions and products. 1 unit. Prerequisite: Mathematics 401, 402, or equivalent.

405. Theory of Fields. Further development of the theory of fields covering topics from valuation theory, ideal theory, units in algebraic number fields, ramification, function fields, local class field theory. 1 unit. Prerequisite: Mathematics 401, 402, or equivalent.

406. Homological Algebra. An axiomatic treatment of the algebraic systems basic in topology. 1 unit. Prerequisite: Mathematics 401, 402, or equivalent.

407. Group Representation Theory. Representation of groups by linear transformations, group algebras, character theory, modular representations. 1 unit. Prerequisite: Mathematics 401, 402, or equivalent.

408. Lie Groups. 1 unit. Prerequisite: Mathematics 332, 404, 441.

410. Logical Foundations of Mathematics, I. A discussion of the logical and philosophical foundations of mathematics; considers propositional and first order functional calculi. 1 unit. Prerequisite: Mathematics 314, or 317, or 347, or Philosophy 333, or consent of instructor.

411. Logical Foundations of Mathematics, II. Continuation of Mathematics 410. Considers Henkin completeness theorem and Gödel incompleteness theorem. 1 unit. Prerequisite: Mathematics 410.

412. Recursive Function Theory. Introduction to recursive functions, study of properties of recursive and recursively enumerable sets, degrees of unsolvability, and the implications of the Church-Turing thesis. 1 unit. Prerequisite: Mathematics 410 or consent of instructor.

413. Set Theory. Zermelo-Fraenkel axiomatic set theory; basic concepts in set theory such as ordinal, cardinal, and rank are considered. 1 unit. Prerequisite: Mathematics 410.

415. Advanced Topics in the Theory of Groups. 1 unit. Prerequisite: Consent of instructor.

416. Advanced Topics in Abstract Algebra. 1 unit. Prerequisite: Consent of instructor.

420. Projective Geometry. 1 unit. Prerequisite: Mathematics 328.

422. Algebraic Geometry. 1 unit. Prerequisite: Mathematics 328.

423. Differential Geometry. 1 unit. Prerequisite: Mathematics 343.

424. Riemannian Geometry. Local and global properties of Riemannian manifolds. 1 unit. Prerequisite: Mathematics 423.

425. Differentiable Manifolds, I. Foundations of modern differential geometry, including multilinear algebra, exterior calculus, Stokes' theorem, Frebenius' theorem, affine connections, elements of Riemannian geometry and Lie groups, sheaves, cohomology of manifolds, the DeRham theorem, differentiable fiber bundles, the holonomy theorem, the Hodge theorem, elements of complex analytic manifolds. 1 unit. Prerequisite: Mathematics 318 and 332.

426. Differentiable Manifolds, II. See Mathematics 425 for description. 1 unit. Prerequisite: Mathematics 425.

428. Topics in Geometry. 1 unit. Prerequisite: Consent of instructor.

430. Elementary Geometry from a Modern Viewpoint. Designed for secondary school teachers of mathematics. Primary purpose of the course is to discuss critically the logical structure and content of Euclidean geometry from the modern point of view. Consideration is given to the historical development of the modern

approach. 1 unit. Prerequisite: One year of experience in the teaching of high school mathematics; consent of instructor.

431. Algebraic Topology, I. Continuation of Mathematics 333. Categories and functors, homotopy groups, singular homology, Kunneth theorem, products in cohomology. 1 unit. Prerequisite: Mathematics 333.

432. Algebraic Topology, II. Continuation of Mathematics 431. CW-complexes, Cech homology, duality, spectral sequences, and other topics. 1 unit. Prerequisite: Mathematics 431.

433. Fibre Spaces. 1 unit. Prerequisite: Consent of instructor.

434. Combinatorial and Differential Topology. 1 unit. Prerequisite: Consent of instructor.

435. General Topology. Separation; global and local compactness and connectedness; compactification and completion; function spaces; other topics. 1 unit. Prerequisite: Mathematics 332 or consent of instructor.

438. Topics in Topology. 1 unit. Prerequisite: Consent of instructor.

439. Seminar in Topology. 1 unit. Prerequisite: Consent of instructor.

440. Theory of Functions of a Complex Variable, I. Application of the elementary theory is made to the study of conformal mappings, Riemann surfaces, entire and meromorphic functions. 1 unit. Prerequisite: Mathematics 348 or consent of instructor.

441. Real Analysis, I. Lebesgue measure on the real line, integration and differentiation of real functions, elementary applications to harmonic analysis. 1 unit. Prerequisite: Mathematics 347 or equivalent.

442. Real Analysis, II. Metric spaces, introduction to functional analysis, integration on general measure spaces. 1 unit. Prerequisite: Mathematics 441.

443. Ordinary Differential Equations. Existence, uniqueness, and continuation of solutions; topics selected from: the theory of linear differential operators, Sturm-Liouville theory, stability theory, qualitative theory of differential equations. 1 unit. Prerequisite: Mathematics 347 and a first course in ordinary differential equations.

444. Partial Differential Equations. 1 unit. Prerequisite: Consent of instructor.

445. Theory of Functions of a Complex Variable, II. 1 unit. Prerequisite: Mathematics 332 and 440, or consent of instructor.

446. Hilbert Space. Geometrical properties of Hilbert spaces; linear operators; the spectral theory for self adjoint and related operators. 1 unit. Prerequisite: Mathematics 442.

447. Banach Spaces. Geometrical properties of Banach spaces; bounded linear operators; applications to analysis; linear topological spaces. 1 unit. Prerequisite: Mathematics 442.

448. Harmonic Analysis. Locally compact groups, Haar measure, Fourier analysis, and Tauberian theorems. 1 unit. Prerequisite: Mathematics 442.

449. Normed Rings. Properties of normed rings; representation as rings of continuous functions or rings of bounded operators; applications to spectral theory, harmonic analysis, etc. 1 unit. Prerequisite: Mathematics 318 and 446 or 447.

450. Ordered Spaces. A study of ordered topological vector spaces and vector lattices and positive operators. 1 unit. Prerequisite: Mathematics 442 and 447.

451. Theory of Probability. 1 unit. Prerequisite: Mathematics 442.

452. **Theory of Probability.** 1 unit. Prerequisite: Mathematics 451.

453. **Analytic Theory of Numbers.** 1 unit. Prerequisite: Mathematics 317 and 348.

454. **Analytic Theory of Numbers.** 1 unit. Prerequisite: Mathematics 453.

455. **Mathematical Methods of Physics.** 1 unit. Prerequisite: Mathematics 348.

456. **Mathematical Methods of Physics.** 1 unit. Prerequisite: Mathematics 455.

457. **Advanced Numerical Analysis.** Same as Computer Science 457. Ordinary differential equations: existence theory of Picard, one-step and multi-step methods, discretization error, convergence, stability, boundary value problems; integral equations. 1 unit. Prerequisite: Computer Science or Mathematics 387 or consent of instructor.

458. **Numerical Solution of Partial Differential Equations.** Same as Computer Science 458. The numerical solution of initial and boundary value problems for partial differential equations; topics include the approximation of differential operators by difference operators, the solution of large systems of linear equations by iterative methods, and discussion of convergence and numerical stability. 1 unit. Prerequisite: Computer Science or Mathematics 457, or consent of instructor.

459. **Topics in Hydrodynamics.** 1 unit. Prerequisite: Consent of instructor.

460. **Relativity and Cosmology.** Same as Astronomy and Physics 424. Elements of tensor calculus and Riemannian geometry; special relativity; Lorentz transformations, equivalence of mass and energy; general relativity and the gravitational field of the sun; galaxies and cosmology. 1 unit. Prerequisite: Consent of instructor. McVittie.

461. **Applied Stochastic Processes.** Introduction to topics such as spectral analysis, filtering theory, and prediction theory of stationary processes; Markov chains and Markov processes. 1 unit. Prerequisite: Mathematics 346 and 347.

463. **Information Theory.** Same as Computer Science and Electrical Engineering 463. Mathematical models for information channels and sources; existence theorems for and construction of error-correcting codes. 1 unit. Prerequisite: Mathematics 361.

465. **Topics in Automata Theory.** Same as Computer Science and Electrical Engineering 465. 1 unit. Prerequisite: Computer Science, Mathematics, or Electrical Engineering 392, or consent of instructor.

468. **Topics in Analysis.** 1 unit. Prerequisite: Consent of instructor.

469. **Seminar in Analysis.** 1 unit. Prerequisite: Consent of instructor.

470. **Statistical Decision Functions.** Statistics from the point of view of decision-making; introduction to the theory of games; minimax and other decision functions; techniques for determining optimal decision functions; applications to nonsequential and sequential decision-making in practice. 1 unit. Prerequisite: Consent of instructor.

473. **The Theory of Testing Hypotheses.** Methods of constructing statistical tests which have optimum properties in small samples; the principles of invariance, unbiasedness and similarity; most stringent tests and minimax tests. 1 unit. Prerequisite: Consent of instructor.

474. **The Theory of Estimation.** Methods of constructing uniformly minimum variance unbiased estimates; minimax estimation; estimation by confidence sets. 1 unit. Prerequisite: Consent of instructor.

478. **Topics in Statistics.** 1 unit. Prerequisite: Consent of instructor.

487. Theory of Approximation. Same as Computer Science 487. General approximation theory in normed linear spaces with primary emphasis on functions defined on an interval, and periodic functions; existence and uniqueness theorems; characterization of Chebyshev approximants; degree of approximation; interpolation with emphasis on the quality of interpolants as approximants; use of approximations in computing. 1 unit. Prerequisite: Mathematics 318, 348, or consent of instructor.

488. Topics in Applied Mathematics. 1 unit. Prerequisite: Consent of instructor.

489. Seminar in Applied Mathematics. 1 unit. Prerequisite: Consent of instructor.

490. Reading Course. 1 to 2 units. Prerequisite: Consent of instructor.

493. Proseminar. An introduction to the methods and tools of mathematical research. The work of the course consists in the solution by the students of assigned problems in various fields of mathematics and the presentation of these solutions in both written and oral form. 1 unit. Prerequisite: Mathematics 347; credit or registration Mathematics 348.

499. Thesis Research. 0 to 4 units. Prerequisite: Consent of instructor. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Theory of Sets and the Real Number System. This course deals with elementary naive set theory and the development of the integers, the rational numbers, and the real numbers; principal emphasis is upon the mathematical needs of the secondary teacher. 1 unit. Prerequisite: One year of calculus or consent of instructor.

301. Fundamental Concepts of Algebra. 1 unit. Prerequisite: One year of calculus or consent of instructor.

302. Topics in Geometry. Historical development of geometry, including tacit assumptions made by Euclid, Euclid's Fifth Postulate and its equivalents, and the discovery of non-Euclidean geometries; geometry as a mathematical structure; finite geometries; geometry as a study of invariants of set transformations; projective geometry; applications of group theory to geometry; vector geometry. 1 unit. Prerequisite: One year of calculus or consent of instructor.

303. Advanced Aspects of Euclidean Geometry. Selected topics from geometry as for example, circumcircle, nine-point circle, theorem on centroid and orthocenter; the construction of regular figures, isometries in the plane and space, rotations and translations, fixed points, ordered and affine geometries, geometry of inversive plane. 1 unit. Prerequisite: One year of calculus or consent of instructor.

305. Teachers' Course. A study of some special teaching problems in arithmetic, algebra, geometry, and trigonometry. Teaching procedures for important topics in these subjects are discussed in relation to their foundations in mathematics and logic. Topics suitable for presentation for superior high school students are also considered. ½ or 1 unit. Prerequisite: One year of calculus or consent of instructor.

306. Selected Mathematical Topics for Secondary School Teachers, I. This course deals with the teaching of the following topics in secondary school mathematics: symbolism and numbers; directed numbers; variables; equations (linear, quadratic, systems); sets; graphs; bases of enumeration; functions; critical examination of these topics. ½ or 1 unit. Prerequisite: One year of secondary school teaching in mathematics or consent of instructor.

307. Selected Mathematical Topics for Secondary School Teachers, II. This course

deals with the teaching of the following topics in high school mathematics: variables in geometry; logic analysis of geometrical propositions; equivalence relations in geometry including congruence and similarity; geometry in the coordinate plane; cosine and sine as real valued functions of real arguments; a comparison of these functions with those ordinarily taught in the high school; symmetry; periodicity; evenness and oddness; exponential and logarithmic functions. ½ or 1 unit. Prerequisite: One year of secondary school teaching in mathematics or consent of instructor.

311. **Advanced Algebra.** For students interested in actuarial science, statistics, or teacher training in mathematics. 1 unit. Prerequisite: One year of calculus or consent of instructor.

312. **Advanced Algebra.** For students interested in actuarial science, statistics, or teacher training in mathematics. 1 unit. Prerequisite: One year of calculus or consent of instructor.

314. **Introduction to Set Theory and Mathematical Logic.** In general, this course supplies the set-theoretic and logical preliminaries for graduate work in mathematics. Contents: sets, relations, and mappings; the notions of constant and variable; the integers; cardinal and ordinal numbers; Zorn's Lemma; the real numbers; informal account of the propositional calculus and first order functional calculus; informal account of various axiomatic theories. 1 unit. Prerequisite: One year of calculus.

315. **Linear Transformations and Matrices.** 1 unit. Prerequisite: One year of calculus.

317. **Introduction to Higher Algebra.** 1 unit. Prerequisite: One year of calculus.

318. **Introduction to Higher Algebra.** 1 unit. Prerequisite: Mathematics 317.

327. **Introduction to Higher Geometry.** 1 unit. Prerequisite: One year of calculus.

328. **Introduction to Higher Geometry.** 1 unit. Prerequisite: Mathematics 327.

332. **Introduction to Set Theory and Topology.** Informal set theory, cardinals, ordinals, Zorn's Lemma, axiom of choice, topology of metric spaces, introduction to general topological spaces, and other topics. 1 unit. Prerequisite: Credit or registration in Mathematics 347.

333. **Introduction to Algebraic Topology.** Fundamental group, complexes, homology, simplicial approximation, structure of Abelian groups, exact sequences, axioms for homology. 1 unit. Prerequisite: Mathematics 318, 332, or consent of instructor.

341. **Differential Equations.** 1 unit. Prerequisite: One year of calculus.

342. **Differential Equations.** 1 unit. Prerequisite: Mathematics 341.

343. **Advanced Calculus.** 1 unit. Prerequisite: One year of calculus.

345. **Differential Equations and Orthogonal Functions.** 1 unit. Credit is not given for both Mathematics 345 and 349. Prerequisite: One year of calculus.

346. **Complex Variables and Applications.** For students who desire a working knowledge of complex variables. Covers the standard topics and in addition gives an introduction to integration by residues, the argument principle, conformal maps, Laplace transforms, and potential fields. Students desiring a systematic development of the foundations of the subject should take Mathematics 348. Credit is not given for both Mathematics 346 and 348. 1 unit. Prerequisite: Mathematics 343 or consent of instructor.

347. **Introduction to Higher Analysis: Real Variables.** 1 unit. Prerequisite: Mathematics 343 or consent of instructor.

348. **Introduction to Higher Analysis: Complex Variables.** 1 unit. Credit is not given for both Mathematics 346 and 348. Prerequisite: Mathematics 347.

349. **Differential Equations and Orthogonal Functions.** An honors course for students with superior mathematical ability. Credit is not given for both Mathematics 349 and 345. 1 unit. Prerequisite: Grade of B or higher in Mathematics 347; and, for undergraduates, registration in Mathematics 249.

350. **Topics in Pure Mathematics.** This is a survey course in pure mathematics for secondary school mathematics teachers. It deals with topics in number theory, topology, and analysis. 1 unit. Prerequisite: Consent of instructor.

351. **Topics in Applied Mathematics.** This is a survey course in applied mathematics for secondary school mathematics teachers. It deals with topics in the application of matrices to physical and social sciences, applications of Boolean algebra, game theory. 1 unit. Prerequisite: Consent of instructor.

353. **Elementary Theory of Numbers.** 1 unit. Prerequisite: One year of calculus.

354. **Elementary Theory of Numbers.** 1 unit. Prerequisite: Mathematics 317 or 353.

357. **Mathematical Models in the Social Sciences.** Uses many models drawn from the social sciences to motivate, illustrate, and give a unified development of topics in the following areas: linear algebra, graph theory, Markov chains, and linear and nonlinear systems of difference equations. 1 unit. Prerequisite: Mathematics 134 or equivalent.

361. **Theory of Probability.** 1 unit. Prerequisite: One year of calculus.

362. **Finite Differences.** 1 unit. Prerequisite: One year of calculus.

363. **Advanced Statistics.** 1 unit. Prerequisite: One year of calculus.

364. **Advanced Statistics.** 1 unit. Prerequisite: Mathematics 363.

365. **Analysis of Variance.** Estimation and hypotheses testing in linear models; one-, two- and higher-way layouts; incomplete layouts; analysis of covariance; random effects models and mixed models. 1 unit. Prerequisite: Mathematics 364 and 315. May be taken concurrently with Mathematics 364.

366. **Theory of Probability.** Continuation of Mathematics 361. Topics covered may include random walks, Markov chains, branching processess, birth and death processes, and theory of queues. 1 unit. Prerequisite: Mathematics 361 or 363.

371. **Actuarial Theory.** 1 unit. Prerequisite: One year of calculus. PETERS.

372. **Actuarial Theory.** 1 unit. Prerequisite: Mathematics 371.

381. **Vector and Tensor Analysis.** 1 unit. Prerequisite: Mathematics 343 or equivalent, or consent of instructor.

382. **Vector, Tensor, and Matrix Methods in Applied Mathematics.** 1 unit. Prerequisite: Mathematics 381 or consent of instructor.

383. **Linear Programming.** Systems of linear inequalities, the standard canonical and general linear problems, simplex method of solution. 1 unit. Prerequisite: One year of calculus.

386. **Laplace Transforms.** 1 unit. Prerequisite: Mathematics 343.

387. **Numerical Analysis.** Same as Computer Science 387. The main topics discussed in this course are error analysis and algorithms for: the solution of equations; the computation of eigenvalues and eigenvectors; numerical quadrature; numerical approximation of functions. 1 unit. Prerequisite: Computer Science 287; a knowledge of elementary matrix algebra, or consent of instructor.

388. **Mathematical Methods in Engineering and Science.** 1 unit. Prerequisite: Mathematics 343.

391. Boolean Algebra and Switching Theory. Same as Computer Science and Electrical Engineering 391. Boolean algebra with applications to sets, logic, electronic and relay combinational circuits: Karnaugh and Quine-McCluskey minimization procedures with applications; introduction to sequential circuits. ½ or 1 unit. Prerequisite: Consent of instructor.

392. Introduction to Automata Theory. Same as Computer Science and Electrical Engineering 392. Semigroups, partially ordered sets, and other algebraic systems; asynchronous machines; abstract synchronous machines and their properties; regular sets; decomposition theory. ½ or 1 unit. Prerequisite: Computer Science, Mathematics, or Electrical Engineering 391, or consent of instructor.

MATHEMATICS (APPLIED)

A wide variety of courses in applied mathematics, covering among others the fields of mechanics of particles and of rigid bodies, the mechanics of continuous media, electromagnetic theory and mathematical methods, is offered by various graduate departments in the sciences and engineering. A graduate student interested in applied mathematics should register as a major in the department of his choice. In consultation with his adviser he should plan a basic course of study which will serve as preparation for subsequent specialization and research in the theoretical aspects of one or more of the following fields: aerodynamics and hydrodynamics, astronomy, elasticity and plasticity, electrical theory, mathematics, mathematical meteorology, or the mathematical problems related to digital computer use and design.

MECHANICAL AND INDUSTRIAL ENGINEERING

The Department of Mechanical and Industrial Engineering offers work leading to the Master of Science and Doctor of Philosophy. Advanced study and professional training are offered in the general fields of power, design, production, and industrial engineering.

The prerequisite for graduate work in mechanical engineering is the equivalent of the undergraduate course requirements of the Bachelor of Science in mechanical engineering at the University of Illinois, with a grade-point average of at least 4.0. The applications of those with grade-point averages below 4.0 but above 3.6 are individually reviewed by the graduate committee and admission is granted if credentials are satisfactory. Students who have obtained graduate credit in some other university may apply for admission provided their undergraduate records meet the above requirements and their grade-point averages in graduate work are at least 4.0.

A minimum of eight units must be completed for the master's degree when a thesis is included. The requirement of a master's thesis may be waived, but a minimum of nine units is then required.

For further information see *Notes on Graduate Study*, available from the Department of Mechanical and Industrial Engineering, 144 Mechanical Engineering Building. Correspondence concerning graduate studies should be addressed to the departmental chairman of the graduate committee, Professor Seichi Konzo.

GRADUATE FACULTY

Professors: H. H. Korst (Head of Department), H. D. Bareither, J. W. Bayne, E. L. Broghamer, B. T. Chao, W. L. Chow, L. E. Doyle, G. W. Harper, W. S. Harris, E. F. Hebrank, J. A. Henry, R. G. Hering, W. L. Hull, S. Konzo, J. L. Leach, R. J. Martin, J. C. Miles,

L. C. Pigage, E. I. Radzimovsky, F. Seyfarth, S. L. Soo, W. F. Stoecker, K. J. Trigger.

Associate Professors: A. L. Addy, R. W. Adkins, W. E. Bair, J. C. Chato, A. M. Clausing, M. I. Dessouky, B. A. Hertig, B. G. Jones, D. H. Offner, L. D. Savage, Jr., R. P. Strout, B. F. von Turkovich, R. A. White.

Assistant Professors: C. S. Larson, F. A. Morrison, C. O. Pedersen, R. F. Timm.

Mechanical Engineering

COURSES FOR GRADUATES

401. Thermodynamics and Transport Properties. Thermodynamic and microscopic considerations for the prediction of properties. Caratheodory principle; relations between properties; microscopic description based on classical statistics; statistical equilibrium and trend toward equilibrium fluctuations; thermodynamics and transport properties; implication of wave mechanics. 1 unit. Prerequisite: Mechanical Engineering 301 or consent of instructor. Soo.

402. Irreversible Thermodynamics. Statistical considerations based on wave mechanics; gases and relativistic modifications; radiation and high temperatures; solids and liquids, systems at low temperatures; reactive systems; electrical and magnetic properties; fluctuations and irreversible thermodynamics. 1 unit. Prerequisite: Mechanical Engineering 301 or equivalent. Soo.

403. Fundamentals of Combustion. Same as Aeronautical and Astronautical Engineering 438. Fundamentals of kinetic theory, transport phenomena, chemical equilibria, and reaction kinetics; flames, their gross properties, structure, and gas dynamics including oscillatory and turbulent burning; solid and liquid propellant combustion; one-dimensional detonation theory including structure and initiation; three-dimensional and other complex detonation waves; supersonic burning. 1 unit. Prerequisite: Mechanical Engineering 305 or Aeronautical and Astronautical Engineering 213.

404. Gas Dynamics. Introduction to theoretical gas dynamics; properties of compressible real fluids, fundamental laws and basic equations for subsonic and supersonic steady and nonsteady motion; interpretations and use in one- and multi-dimensional problems. 1 unit. Prerequisite: Differential equations, thermodynamics, fluid mechanics. Addy, Chow, Korst.

405. Convective Heat Transfer. Fundamentals of convective heat transfer; calculation of heat transfer within conductor and over submerged objects for laminar and turbulent flow; natural convection; film condensation and boiling; liquid metals. 1 unit. Prerequisite: Mechanical Engineering 306 or consent of instructor. Chao, Clausing, Hering.

406. Heat Conduction in Solids. Fundamentals of heat conduction in isotropic and anisotropic solids; methods of solution to steady and transient heat conduction problems in one, two, and three dimensions; internal heat sources; periodic flow of heat; problems involving phase change; approximate analytical techniques. 1 unit. Prerequisite: Mechanical Engineering 306, Mathematics 346, or consent of instructor. Chao, Hering.

407. Selected Topics in Gas Dynamics. Theoretical analysis of nonsteady processes including scavenging, pulse jet, shock tube, and complex compressor. Includes an introduction to high velocity laboratory techniques. 1 unit. Prerequisite: Mechanical Engineering 404. Chow, Korst.

408. **Laboratory Investigation in Thermodynamics.** Special investigations involving thermodynamics analysis, thermodynamic properties, and performance of physical and chemical systems. ½ to 1½ units. Prerequisite: One-year course in thermodynamics; one half-year course in power laboratory. BAIR, MORRISON, SOO.

409. **Laboratory Investigations in Fluid Flow, Heat Transfer, and Combustion.** Special investigation in flow, metering, heat transfer, heat exchanger performance and design. ½ to 1½ units. Prerequisite: Courses in thermodynamics and fluid mechanics. ADDY, BAIR, CHAO, CHOW, CLAUSING, HERING, JONES, KORST, SAVAGE, WHITE.

410. **Thermal Radiation.** Fundamentals of radiant energy transport in absorbing and non-absorbing media; pyrometry; applications to selected problems involving combined energy transport mechanisms. 1 unit. Prerequisite: Mechanical Engineering 306 or consent of instructor. CHAO, HERING.

421. **Environmental Control.** Physiological reactions of humans to thermal and atmospheric environments, principles of ventilation, air-handling systems, free-stream jets and air distribution, illumination, sound, and acoustics. 1 unit. Prerequisite: Undergraduate courses in heat transfer and fluid mechanics. STOECKER.

423. **Air Conditioning and Refrigeration.** Load calculation, thermal system performance and optimization, static and dynamic control, industrial refrigeration absorption, thermoelectric, and cryogenic refrigeration. 1 unit. Prerequisite: Undergraduate courses in heat transfer and fluid mechanics. STOECKER.

428. **Laboratory Investigations in Refrigeration.** Special investigations in refrigeration. ½ to 1½ units. CHATO, PEDERSEN, STOECKER.

429. **Laboratory Investigation in Heating and Air Conditioning.** Special investigations in heating, ventilating, and air conditioning. ½ to 1½ units. Prerequisite: Two semesters of power laboratory or equivalent. CHATO, HARRIS, HERTIG, KONZO, PEDERSEN, STOECKER.

432. **Theory of Rotary Compressors.** Thermodynamical and mechanical fundamentals, compression with and without cooling, classification of compressors, similarity considerations and characteristics, principles of and computations for radial compressors, improvement in performance of integrating parts; axial flow compressors; lattice and airfoil theory; change in operating conditions of turbo-compressors; regulation; rotary positive blowers. 1 unit. Prerequisite: Mechanical Engineering 205, 206, and 212; or Theoretical and Applied Mechanics 232; or Aeronautical and Astronautical Engineering 211. KORST.

438. **Laboratory Investigations in Power Machinery.** Special investigations in power machinery, such as turbines, engines, fans, and compressors. ½ to 1½ units. Prerequisite: One-year course in power laboratory. HEBRANK, HULL, STROUT.

441. **Machine Design.** A technical application course designed to focus the previously acquired design experience on the creative problem of developing machines to perform specified functions; proper considerations of manufacturing processes involved; checking of all parts for stress, wear, vibration, fatigue, etc. 1 unit. Prerequisite: Undergraduate course in dynamics of machines; one year of machine design. ADKINS.

442. **Linkage Synthesis.** Geometry of constrained motion in two and three dimensions; application of mathematical and other techniques to the synthesis of mechanisms. 1 unit. Prerequisite: Mechanical Engineering 342 or consent of instructor. BROGHAMER.

443. **Dynamics of Machinery.** Complementary to the undergraduate course and devoted to a more detailed study of velocities, accelerations, and forces in

machine parts having reciprocating, rotating, and combined motions; balancing, flywheels; special topics. 1 unit. Prerequisite: Undergraduate course in dynamics of machines; one year of machine design. TIMM.

445. Design of Internal Combustion Engines. Detailed study of the design of the internal combustion engine; gas-pressure and inertia-force diagrams; determination of bearing loads; torsional vibration analysis; stress determinations and design of important parts, including piston, connecting rod, crankshaft, flywheel, valve mechanism, and cam layout. 1 unit. Prerequisite: Undergraduate courses in dynamics of machines and in internal combustion engines; one year of machine design. HULL.

448. Laboratory Investigations in Machine Design. Special investigations in machine design. ½ to 1½ units. ADKINS, BROGHAMER, LARSON, OFFNER, RADZIMOVSKY, TIMM.

451. Theory of Metal Cutting. A study of the theoretical factors involved in metal cutting and forming; basic mechanics of chip formation, friction, surface damage and finish; temperatures and temperature distribution during cutting; wear and tool-work compatibility. Analysis of experimental data; critical review of pertinent literature and special topic assignments. 1 unit. Prerequisite: Undergraduate course in principles of metal cutting and heat treatment of metals or physical metallurgy. TRIGGER.

452. Deformation and Mechanical Processing of Metals. Theoretical and experimental aspects of deformation and mechanical processing of metals. Plastic deformation; fracture and fatigue; impact stresses and stress waves in metals; thermal and residual stresses; plastic forming of metals and its influence on the properties. 1 unit. Prerequisite: Mechanical Engineering 451; Metallurgical Engineering 408. VON TURKOVICH.

458. Laboratory Investigations in Production. Special investigations in field of production, particularly in materials processing, metal cutting, and production engineering. ½ to 1½ units. BARDES, DOYLE, KLEIN, LEACH, TRIGGER, VON TURKOVICH.

493. Seminar. Required of all M.S. candidates. Presentation and discussion of significant developments in mechanical engineering. No credit. KONZO.

499. Thesis Research. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Thermodynamics. Basic considerations of the three laws of thermodynamics; elementary statistical principles for the prediction of properties of pure substances and mixtures; transport properties, electric and magnetic systems. ¾ or 1 unit. Prerequisite: Mechanical Engineering 206 or equivalent; consent of instructor. SOO.

302. Nuclear Power Engineering. Principles of release and exploitation of nuclear energy; uranium fission and the controlled chain reaction, reactor types and design principles; radiation hazards and shielding, adaptation and economics. ¾ or 1 unit. Prerequisite: Consent of instructor. JONES.

304. Direct Energy Conversion. Direct conversion of chemical, nuclear, and solar energies into electricity by electrochemical, thermionic, thermoelectric, photoelectric, photochemical, ferroelectric, magnetohydrodynamic, and plasma systems. ¾ or 1 unit. Prerequisite: Mechanical Engineering 301 or consent of instructor; Mathematics 345. SOO.

305. Thermodynamics of High-Velocity Flow. The thermodynamics of gases during high-velocity flow within enclosed channels using Mach number as the funda-

mental variable; analyses of the basic flow equations, effects of friction and plane shock theory; application to thermodynamic cycles involving nozzles, diffusers, compressors, combustion, and turbines. ¾ or 1 unit. Prerequisite: Mechanical Engineering 206, or 211, or consent of instructor. ADDY, CHOW, WHITE.

306. Industrial Heat Transfer. Theory and application of numerical, analogical, and experimental methods to selected heat transfer problems; application of principles of convection, condensation, and boiling heat transfer to design of heat exchange equipment. 1 unit. Prerequisite: Undergraduate courses in fluid mechanics and heat transfer. CLAUSING, HERING.

309. Experimental Gas Dynamics. Experimental investigation of problems in the field of compressible fluid flow within enclosed channels. 1 unit. Prerequisite: Mechanical Engineering 211, or 305, or consent of instructor. ADDY, CHOW, WHITE.

311. Instrumentation and Measurements. Same as Agricultural Engineering 311. Accuracy, precision, and statistical consideration of measurement data; dynamics of measurement; displacement, velocity, acceleration, force, torque, pressure, and temperature measurements; mechanical impedance; measurements on fluids; instrumentation systems. ¾ or 1 unit. Prerequisite: Senior standing in engineering or science. STROUT.

312. Theory of Controls. Introduction to the theory of controls. Dynamical analysis of physical systems; steady-state operations; graphical and analytical methods of analysis; applications. ¾ or 1 unit. Prerequisite: Consent of instructor. KLEIN, VON TURKOVICH.

314. Lubrication. The theoretical basis of lubrication; hydrodynamic bearing theory; properties of lubricants; methods of testing; lubrication methods and appliances; study of the lubrication requirements of machines of many kinds. ¾ or 1 unit. Prerequisite: Undergraduate courses in machine design and fluid mechanics. ADKINS, OFFNER, RADZIMOVSKY.

323. Design of Thermal Systems. Selection of components in fluid- and energy-processing systems to meet system performance requirements, computer-aided design, system simulation, optimization techniques, investment economics, and statistical combinations of operating conditions. ¾ or 1 unit. Prerequisite: Mechanical Engineering 206, 211, and 213. STOECKER.

332. Theory of Internal Combustion Engines. Analysis of reciprocating engine cycle including thermodynamics and combustion and taking into consideration effects of fuel-air mixture, variable specific heats, chemical equilibrium and dissociation, and heat losses; flow through manifolds and valves; factors affecting breathing and scavenging; supercharging; bearings, lubrication, and function; effects of variables on performance. ¾ or 1 unit. Prerequisite: Undergraduate course in internal combustion engines or consent of instructor. HULL.

341. Engineering Analysis and Design. Correlation of previously acquired design experience with the creative problems of synthesis and analysis that depend upon design judgment. ¾ or 1 unit. Prerequisite: Mechanical Engineering 271 or consent of instructor. ADKINS, BAYNE, BROGHAMER.

342. Kinematic Analysis and Synthesis. Geometry of constrained motion; application of mathematical and other techniques to the kinematic analysis and synthesis of mechanisms. ¾ or 1 unit. Prerequisite: Undergraduate course in kinematics or consent of instructor. BROGHAMER.

343. Dynamics of Machinery. A course complementary to the undergraduate course with emphasis on the analytical approach to the study of dynamic forces in machines, balancing, critical speeds, shaft vibrations, governors, and gyroscopes.

¾ or 1 unit. Prerequisite: Mechanical Engineering 221 or consent of instructor. BROGHAMER, TIMM.

388. Machine Tool Systems Analysis. A study of the components, their analysis and synthesis in machine tool systems; power components, precision motion, dynamic response of machine skeleton, linear and nonlinear conditions, control elements, and computer control of machines. ¾ or 1 unit. Prerequisite: Mechanical Engineering 186, 271, or consent of instructor. VON TURKOVICH.

Industrial Engineering

COURSES FOR GRADUATES

401. Scientific Management, I. Same as Industrial Administration 401. A study of modern management principles on the basis of quantitative methods, concentrating on such operation research techniques as nonlinear and dynamic programming and queueing theory. 1 unit. Prerequisite: Industrial Engineering 386 and Mathematics 361, or consent of instructor.

402. Scientific Management, II. Same as Industrial Administration 402. A systems approach to industrial problems involving inventory control, scheduling and line balancing, maintenance and investment theory; application of formally accumulated knowledge of operation research techniques. Problems from industry are assigned to small teams of students. 1 unit. Prerequisite: Industrial Administration or Industrial Engineering 401; background in computer technology or consent of instructor.

416. Design of Construction and Industrial Operation, I. Same as Civil Engineering 416. Conceptual development of a systems design procedure for optimal design of construction and industrial operations; general forms required for critical path networks, linear programs, theory of queues and inventory models required for systems design; design evaluation and control models. 1 unit. Prerequisite: Bachelor of Science in civil or industrial engineering; credit or registration in Mathematics 363; or consent of instructor.

417. Design of Construction and Industrial Operations, II. Same as Civil Engineering 417. Continuation of Industrial Engineering 416. 1 unit. Prerequisite: Industrial Engineering or Civil Engineering 416; credit or registration in Mathematics 315; or consent of instructor.

453. Work Measurement. A study of special problems of line balance, interference, and automation work loads as required to establish work standards (or production standards) . 1 unit. Prerequisite: Industrial Engineering 332. PIGAGE.

454. Production Engineering. Advanced consideration of production engineering principles as related to cost analysis and reduction, control of flow of work in manufacture, evaluation of performance against standard, and compensation. Special investigations. 1 unit. Prerequisite: Industrial Engineering 453. PIGAGE.

458. Laboratory Investigations in Industrial Engineering. Special investigations of such problems as optimization of operations, programming systems, work standards, plant layout, and flow of materials. ½ to 1½ units. STAFF.

473. Ergonomics Seminar. Same as Physiology 473. Topics in ergonomics are explored in depth, such as effects of vibration on human performance, biomechanics of the hand, and functional dimension. ½ unit. Prerequisite: Industrial Engineering 305 or consent of instructor.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

304. Principles of Ergonomics. Same as Physiology 304. Concepts and design criteria to achieve optimum mutual adjustment of man and his work. Topics such as

static and dynamic forces on the human frame, response to environmental stress (heat, vibration, noise), vigilance and fatigue, and man-machine systems are considered. 1 unit. Prerequisite: Consent of instructor. HERTIG.

305. Quantitative Methods in Ergonomics. Same as Physiology 305. Laboratory problems and discussion on measurements of the physical and mental capacities and limitations of human beings in relationship to the stresses and demands of working environment. Students become familiar with techniques and tools such as assessment of human energy expenditures on an industrial job, use of seating research chair; high speed and time lapse photography. Student teams select about six problems from a list of topics, or they may develop problems of special interest to the team. 1 unit. Prerequisite: Physiology or Industrial Engineering 304.

306. Quantitative Methods in Ergonomics. Same as Physiology 306. Laboratory problems and discussion on measurements of the physical and mental capacities and limitations of human beings in relationship to the stresses and demands of working environment. Students become familiar with techniques and tools such as assessment of human energy expenditures on an industrial job, use of seating research chair; high speed and time lapse photography. Student teams select about six problems from a list of topics, or they may develop problems of special interest to the team. 1 unit. Prerequisite: Physiology or Industrial Engineering 305.

332. Standard Time Systems. The study of development, uses, and limitations of standard time data and predetermined time system. ¾ or 1 unit. Prerequisite: Industrial Engineering 232. PIGAGE.

333. Engineering Applications of Statistics. Applications of statistics to engineering problems; the calculated risk in making decisions on observed data; treatment of means, percentage, and variability; control charts, acceptance sampling, linear regressions, correlation, elementary experimental design. Use of desk calculators. ¾ or 1 unit. Prerequisite: Mathematics 263 or 363. HENRY.

334. Introduction to Reliability Engineering. Same as General Engineering 334. An introduction to concepts in engineering design, testing, and management for highly reliable components and systems. ¾ or 1 unit. Prerequisite: Industrial Engineering 333, or Mathematics 361, or equivalent with consent of instructor. HENRY.

350. Manufacturing Process and Tool Design. A study of and exercises in the design of manufacturing processes and tools for maximum efficiency; the utilization of computer techniques in design of manufacturing processes and tools. ¾ or 1 unit. Prerequisite: Industrial Engineering 282 or a course in engineering economy. DOYLE.

355. Numerical Control of Manufacturing Processes. A study of numerical control systems, manufacturing processes, principles and practices basic to numerical control, and programming methodology for numerical control. ¾ or 1 unit. Prerequisite: Mechanical Engineering 186 or consent of instructor; background in computer technology. DOYLE.

357. Safety Engineering. The study of engineering principles applied to industrial accident prevention; safe plant layout, safety in maintenance, boilers and pressure vessels, design and application of machine guards, material handling and storage, hand and power tools, welding hazards, electrical hazards, flammable liquids and fire protection, industrial health engineering and toxic materials. ¾ or 1 unit. Prerequisite: Consent of instructor. HARPER.

358. Problems in Safety Engineering. Extended and intensified study of specific safety problems; study of industrial safety procedures and methods of application. Designed to provide sound knowledge of accident prevention principles

and applications for the student interested in entering the field of safety engineering in industry. ¾ or 1 unit. Prerequisite: Industrial Engineering 357; consent of instructor. HARPER.

359. Industrial Fire Protection. Technical study of fire protection based on engineering analysis; fire losses in industry, occupancy fire hazards, methods of fire prevention, fire detection equipment, control of fire, water supplies and extinguishment methods, hazardous materials, industrial fire brigades, and public fire departments. ¾ or 1 unit. Prerequisite: Credit or registration in Industrial Engineering 357 or consent of instructor. HARPER.

386. Industrial Engineering Analysis. Analysis and development of analytical techniques for the solution of problems in industrial engineering; application of statistical methods to uncertainty problems; analysis of linear programming techniques appropriate to the solution of allocation problems dealing with materials, money, men, and machines; queueing theories applied to maintenance and inventories. ¾ or 1 unit. Prerequisite: Mathematics 263, Industrial Engineering 286, or consent of instructor. DESSOUKY, WALLHAUS.

MICROBIOLOGY

See descriptions and course listings under Life Sciences, page 277.

MINING, METALLURGY, AND PETROLEUM ENGINEERING

The Department of Mining, Metallurgy, and Petroleum Engineering offers graduate work leading to the Master of Science and Doctor of Philosophy. The prerequisite for graduate work in metallurgical or mining engineering is the equivalent of the undergraduate courses in either of these majors which are required for the Bachelor of Science at the University of Illinois. For these major fields a Bachelor of Science in some related field may also be acceptable.

Those wishing to specialize in petroleum engineering or in the more general area of petrophysics should have a Bachelor of Science in engineering with advanced courses in mathematics, chemistry, physics, and/or geology.

A candidate for the Master of Science is required to have a minimum of eight units of graduate work, including a thesis. If a petition to waive the thesis requirement is granted, a minimum of nine units of graduate work is required. A thesis is required of candidates who hold research assistantships.

Students desiring to work for the Doctor of Philosophy are required to pass the departmental qualifying examination. This examination must be taken no later than the end of the first semester after receiving the Master of Science from this department, or not later than the end of the second semester in residence, if the student has a Master of Science from some other department or university.

The minor requirement of the Graduate College for the Doctor of Philosophy may be satisfied by taking courses in fields such as ceramics, chemistry, geology, mathematics, theoretical and applied mechanics, nuclear engineering, and physics.

GRADUATE FACULTY

Professors: C. A. WERT (Head of Department), P. A. BECK, H. K. BIRNBAUM R. W. BOHL, W. H. BRUCKNER, A. J. DE WITTE, E. J. ECKEL G. EHRLICH, D. S. LIEBERMAN, M. METZGER, B. G. RICKETTS, H. E RISSER, T. J. ROWLAND, A. E. SCHEIDEGGER, C. M. WAYMAN.

Associate Professors: C. J. ALTSTETTER, D. BOND, F. V. LAWRENCE, JR., J. SIMON

Mining Engineering

COURSES FOR GRADUATES

401. Advanced Mineral Dressing and Coal Preparation. Advanced theory and practice of mineral dressing and coal preparation processes. 1 unit.

402. Mine Valuation, Taxation, and Mineral Economics. A study of current methods of evaluating mine properties; methods of taxation of mine properties and mineral reserves; and the relation of mineral resources to economics of society. 1 unit.

405. Advanced Mine Ventilation. Study of physics of air, air conditioning for mines, mine ventilation systems, selection of fans for mines, ventilation surveys and instrumentation. 1 unit. Prerequisite: Consent of instructor.

406. Design of Underground Openings. Engineering problems in the design of underground openings; geologic structure and stress analysis in relation to underground openings. 1 unit. Prerequisite: Mining Engineering 356.

414. Physical Chemistry of Clays and Soils. Same as Agronomy and Ceramic Engineering 414. The application of physical chemical principles and concepts to surfaces and adsorption on surfaces. Silicate surfaces and water adsorption are emphasized. 1 unit. Prerequisite: Chemistry 340 and 341, or equivalent, or consent of instructor.

497. Special Problems. Individual studies in areas of mining or petroleum engineering, not covered by regular course offerings, carried out under the supervision of a member of the staff. 0 to 2 units. Prerequisite: Consent of instructor.

499. Thesis Research. Individual research in some phase of the general field of mining or petroleum engineering under the supervision of a member of the staff. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Mineral Processing. Crushing, grinding, flotation, proximate analysis of coal, pumping of fluid-solid mixtures, quality control in ore dressing. ¾ unit.

302. World Mineral Economics. The role of minerals in a productive economy; the interdependence of minerals in industrial society and the problems arising out of their unequal geographic distribution and divided political control. ¾ or 1 unit.

351. Geophysical Prospecting. Same as Geology 351. Principles of geophysics and their application to mining processes. ¾ or 1 unit. Prerequisite: Consent of instructor.

353. Sampling, Exploration, Valuation. Theory of sampling applied to mineral deposits and concentrating plants; geological principles of exploration; surface and subsurface exploration; valuation. ¾ or 1 unit. Prerequisite: Geology 101 and 130; Mathematics 263.

356. Rock Mechanics. Mechanical properties of rocks; design of mine openings in bedded, massive, and fractured rock; methods of support; drilling; blasting. ¾ or 1 unit. Prerequisite: Mining Engineering 351.

360. Analysis and Design of the Mining System. Analyses of unit operation cycles and production methods; design of materials handling systems and applications of operations research. 1 unit. Prerequisite: Mathematics 263; credit or registration in Mining Engineering 356.

393. **Special Problems.** Individual studies of any phase of mining or petroleum engineering selected by the student and approved by his adviser and the staff member who will supervise the study. 0 to 1 unit. Prerequisite: Consent of instructor.

Metallurgical Engineering

COURSES FOR GRADUATES

406. **Advanced Physics of Metals.** The free electron theory of metals; the zone theory of metals; magnetism and electrical conductivity. 1 unit. Prerequisite: Metallurgical Engineering 405, or Physics 385, or consent of instructor.

407. **Plastic Deformation and Annealing of Metals.** The mechanism and crystallography of plastic deformation of single crystals and of polycrystalline metals; annealing effects: recovery, subgrain growth and recrystallization; deformation textures and annealing textures. 1 unit. Prerequisite: Consent of instructor.

408. **Dislocations and Mechanical Properties of Metals.** General static and dynamic properties of single dislocations in crystals; dislocation interactions; properties of dislocation arrays; role of dislocations in metallurgical phenomena with particular emphasis on mechanical properties. 1 unit. Prerequisite: Consent of instructor.

409. **Crystal Physics.** The anisotropic properties of crystals treated by tensor and matrix methods with applications to paramagnetism, conduction and diffusion, thermoelectricity, deformation, elasticity, and martensitic transformations. The effects of crystal symmetry and the properties of aggregates are discussed. 1 unit. Prerequisite: Vector algebra, determinants, and thermodynamics; consent of instructor.

410. **Advanced X-Ray Metallography.** X-ray diffraction as applied to the study of metals and alloys; effects of cold work, annealing, substructures, preferred orientation and ordering, principles of electron and neutron diffraction. 1 unit. Prerequisite: Chemistry 427 or consent of instructor.

420. **Metallurgical Thermodynamics.** Fundamental thermodynamic considerations and applications of thermodynamics to metallurgical problems; particular emphasis on heterogeneous equilibrium and thermodynamic properties of solutions; topics approached from the viewpoints of both macroscopic thermodynamics and statistical mechanics. 1 unit. Prerequisite: Metallurgical Engineering 314 or equivalent.

421. **Kinetics of Phase Changes in Metals.** The viewpoint of statistical thermodynamics, rate theory, diffusion in solids, interface energy, nucleation theories phenomenological analysis of nucleation and growth; application to crystal growth, diffusionless phase changes, oxidation, pearlite reaction, precipitation sintering. 1 unit. Prerequisite: Metallurgical Engineering 420 or consent of instructor.

485. **Metallurgical Engineering Problems.** Individual study in areas of metallurgical engineering not covered by regular course offerings, carried out under the supervision of a member of the staff. ¼ to 2 units. Prerequisite: Consent of instructor.

486. **Laboratory Investigations in Metallurgy.** Special investigations in metallurgy to provide an opportunity to employ some advanced experimental methods of research. Available only to non-thesis students enrolled in a Master of Science program. ¼ or ½ unit. Prerequisite: Consent of instructor.

93. Seminar in Anelasticity. Lectures and discussions of the nature of anelasticity and its application to metallurgy. 0 or ¼ unit. Prerequisite: Consent of instructor.

94. Seminar on Phase Transformations in Metals. Discussion of current research in this field including presentation by graduate students of their own work. 0 or ¼ unit. Prerequisite: Consent of instructor.

95. Seminar on Diffusion and Imperfections. Lectures and discussions on diffusion and imperfections in crystalline solids. 0 or ¼ unit. Prerequisite: Consent of instructor.

97. Seminar on Alloy Phases. Discussion and lectures on current research, including work by the graduate students, relating to the electronic structure and crystal structure of alloy phases. 0 or ¼ unit. Prerequisite: Consent of instructor.

98. Colloquium in Physical Metallurgy. Review of current metallurgical research in other laboratories by visiting lecturers. Some of the research currently done in the department is also reviewed. Required of all graduate students in metallurgical engineering. No credit.

99. Thesis Research. Individual research in specialized problems under the supervision of members of the staff. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Metallurgy of Welding. Heat flow and thermal cycles in welding and cutting of metals; physical metallurgy and mechanical properties of weld metal and thermally altered base metal; joining methods in relation to composition, microstructure, and mechanical properties; specifications, economics, and service requirements. ¾ or 1 unit. Prerequisite: Metallurgical Engineering 208 or equivalent.

302. Powder Metallurgy. Production and testing of powdered metals; fabrication and application of metal shapes produced from powdered metals. ½ or ¾ unit. Prerequisite: Approval of department; registration in Metallurgical Engineering 304.

304. Powder Metallurgy Laboratory. Experiments involving the testing, briquetting, sintering, repressing of metal powders, and the testing of sintered compacts. ¼ unit. Prerequisite: Approval of department; registration in Metallurgical Engineering 302.

306. Design of Engineering Alloys. A study of the fundamental principles which determine the constitution, structure, treatment, and application of alloy steels and other special-purpose high-performance alloys. ¾ or 1 unit. Prerequisite: Metallurgical Engineering 208 and 311.

307. Corrosion of Metals. Electrochemistry, thermodynamics, and kinetics of corrosion; behavior of ferrous and nonferrous metals; corrosion rates; corrosion control, cathodic and anodic protection; high-temperature corrosion; corrosion testing; electrolytic machining methods. ¾ or 1 unit. Prerequisite: Mechanical Engineering 234 or equivalent.

310. X-Ray Metallography. X-ray generation and scattering with applications to problems in physical metallurgy, such as phase identification, the determination of solid solubility, the measurement of grain size and preferred orientation, and other topics. ¾ unit. Prerequisite: Physics 108.

311. Advanced Phase Diagrams. Interpretation of multicomponent phase diagrams for metal systems. ½ unit. Prerequisite: Metallurgical Engineering 201 or equivalent.

314. Metallurgical Thermodynamics. Thermodynamic principles are applied to the study of phase and chemical equilibrium and to the calculation of free energy of phases. ¾ unit. Prerequisite: Credit or registration in Chemistry 246.

315. Metallurgical Kinetics. Diffusion and heat flow calculations and their applications to kinetics of metallurgical processes. ¾ unit. Prerequisite: Metallurgical Engineering 208 and 314.

316. Mechanical Metallurgy. Fundamentals of plastic deformation of crystalline solids; elementary theory of statics and dynamics of dislocations; applications to deformation of single crystals and polycrystals; fracture; effect of metallurgical variables on mechanical properties. ¾ unit. Prerequisite: Consent of instructor.

318. Physics of Metals. The nature of the perfect and imperfect crystal, the electronic structure of solids, electrical conduction in metals and semiconductors, dielectric and magnetic properties of solids. ¾ unit. Prerequisite: Consent of instructor.

334. Physical Metallurgy for Engineers. Fundamentals of crystallography, imperfections, alloying, deformation. Consideration of composition temperature, and prior thermal and mechanical treatment in the use of metals, with emphasis on their mechanical properties. ¾ or 1 unit. Prerequisite: Credit or registration in Theoretical and Applied Mechanics 221 or Aeronautical and Astronautical Engineering 224, or consent of instructor.

384. Properties of Solids. Same as Electrical Engineering 384. Perfect and imperfect crystal lattices, electronic structure of solids including basic theory and applications to transport properties of metals and semiconductors, semiconductor diodes; dielectric and magnetic properties of solids. ¾ unit. Prerequisite: Physics 383.

386. Electron Microscopy and Diffraction Theory. Theory and application of transmission electron microscopy and diffraction with emphasis on thin crystals. Electron optics, interference phenomena, interpretation of images and diffraction patterns, specimen preparation, etc. Students interested in laboratory experience may enroll in Chemistry 429. 1 unit. Prerequisite: Metallurgical Engineering 310 or equivalent.

387. Advanced Physical Metallurgy. Continuation of Metallurgical Engineering 201. Relation of structure to properties of metals; phase transformations; surface reactions; effect of forming processes on properties. Credit not allowed for both this course and Metallurgical Engineering 208 or 251. ¾ unit. Prerequisite: Metallurgical Engineering 201 or 334, or consent of instructor.

388. Advanced Physical Metallurgy Laboratory. Use of physical and mechanical properties and metallography to study metals. To be taken concurrently with Metallurgical Engineering 387. ¾ unit. Prerequisite: Registration in Metallurgical Engineering 387.

Petroleum Engineering

COURSES FOR GRADUATES

420. Porous Media Hydromechanics. Introduction to theoretical hydromechanics. Classification of fluids, fundamental laws and basic equations of motion applicable to microscopic and macroscopic regimes; treatment of interfacial forces and surfaces in multi-phase flow as particularly applied to porous media systems. ¾ or 1 unit. Prerequisite: Mathematics 343, Petroleum Engineering 373, or consent of instructor.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

371. Reservoir Mechanics, I. The mechanics of the movement of fluids in the porous rock reservoirs of the subsurface, especially as related to questions dealing with the production and storage of petroleum fluids, ground water, and natural gases. 1 unit. Prerequisite: Mathematics 345; Theoretical and Applied Mechanics 235.

372. Reservoir Mechanics, II. A continuation of Petroleum Engineering 371, showing the application of the fundamental concepts in developing procedures for forecasting the future performance of reservoir systems as derived from a knowledge of initial and boundary conditions, and as derived with reference to the past history of fluid movement and displacement. 1 unit. Prerequisite: Petroleum Engineering 371.

373. Advanced Reservoir Engineering. Physical principles of oil production including the hydrodynamics of the recovery process with attention given to the valuation and practical economic aspects. ¾ or 1 unit. Prerequisite: Mathematics 345, Petroleum Engineering 372, or consent of instructor.

MUSIC

The School of Music offers the Master of Music, Doctor of Musical Arts, Doctor of Philosophy in Musicology, Master of Science in Music Education, Advanced Certificate in Music Education, and Doctor of Education with a major in Music Education. Inquiries concerning graduate work in music should be addressed to Duane A. Branigan, Director of the School of Music, 100 Smith Music Hall.

Master of Music. The major field may be in musicology, music theory and composition, or performance and literature (organ, voice, piano, violin, viola, cello, solo wind instruments, and percussion instruments).

The admission requirement, in terms of grade-point average, is at least 3.5. In addition, an applicant is required: (1) to have finished successfully a four-year undergraduate curriculum in music or music education, or its equivalent, at the University of Illinois or another accredited institution; and (2) to pass a qualifying examination in the major field of concentration. If the major is to be performance and literature, this examination is essentially one of performance on the major instrument. If an applicant is unable to appear before the graduate committee, recordings may be substituted. If the major is to be musicology, theory, or composition, applicants must present to the committee writings or other evidence of their ability to pursue work on the graduate level. For the field of musicology, a reading knowledge of German or French is required. Candidates in voice should have had one year each of French, German, and Italian, unless two years of one language have been completed in high school. All prospective candidates for the Master of Music must take a placement examination in the history of music and the theory of music.

Doctor of Musical Arts. The fields of specialization for this degree are limited to those areas which can serve properly as a basis for the development of the comprehensive type of musicianship and scholarship the candidate is expected to exhibit. The degree programs comprise the following major areas: composition, choral music, piano, organ, violin, viola, cello, voice, and wind instruments.

In addition to meeting the general requirements for admission to the Graduate College, an applicant must obtain the recommendation of the graduate committee

of the School of Music in order to be admitted to this program. The prerequisites for admission are as follows:

(1) The Master of Music with major field in one of the areas listed above, including work as follows (or its equivalent):

(a) Major in Composition: advanced composition, two units; theory, two units; Music 428, Problems and Methods, one unit; electives, three units.

(b) Major in Performance and Literature: performance and literature, two units; special literature, two units; Music 428, Problems and Methods, one unit; electives, three units.

(2) A high level of proficiency in composition or performance.

(3) Appropriate experience in ensemble playing and/or score reading.

(4) The successful completion of approximately thirty-two semester hours (or the demonstration of an equivalent background) in the liberal arts and sciences including a minimum of six hours in each of the following: general history, literature, and philosophy. Students lacking an appropriate background in liberal arts and sciences may be admitted provisionally, providing they satisfy the stated requirements before taking the preliminary examination.

(5) Successful completion of entrance examinations. These examinations in performance and literature, the history of music, and the theory of music must be taken immediately prior to the student's first registration. Prospective applicants should write to the School of Music, 100 Smith Music Hall, for complete information concerning the nature of these examinations.

If the candidate fails to pass the entrance examinations, he must repeat and pass all or parts of them no later than the end of the second semester in residence, or pass deficiency courses with grades of at least B. Until the examinations or courses have been passed, the student is considered to have a provisional status.

After admission to the doctoral program, the student must fulfill all requirements of the Graduate College pertaining to residence, number of units of graduate work, examinations, grades, and major and minor fields. The language examinations may be selected from the following depending upon the thesis topic: German, French, Russian, Italian, Spanish, Portuguese, Arabic, and Japanese. The selection must have the approval of the doctoral committee.

A minimum of sixteen units of graduate credit beyond the eight units required for the Master of Music is necessary to earn the Doctor of Musical Arts. In the fields of composition, and performance and literature, three units are devoted to the completion of a special doctoral project: for the former, the writing of an original score on a large scale; for the latter, the study of a comprehensive repertory and either two solo recitals, or one solo recital and two of the following options: (1) a concerto performance; (2) the performance of a major role in an opera or oratorio; (3) a chamber music program; (4) a lecture recital; (5) a coaching performance of an instrumental or vocal ensemble. Two units are devoted to the completion of an original thesis. In the field of choral music, one unit is devoted to a doctoral project involving the preparation and presentation of a choral program of approximately one hour in length selected from a comprehensive repertory. Four units are devoted to the completion of an original thesis.

In addition to the above, work for the Doctor of Musical Arts includes the following required courses: composition or performance and literature, three units; Music 420, Seminar in Music Literature, for doctoral candidates, two units. One unit of work must be taken in the field of education or music education unless the candidate has previously passed equivalent course work. At least two, but no more than four units, are normally devoted to an outside minor field. If, however, in the opinion of the graduate adviser, the candidate has acquired a strong background in general education, including history, philosophy, and literature, he may substitute an inside minor in such fields as musicology, ethnomusicology, theory, or composition. Candidates for the Ph.D. in Musicology may substitute ethnomusicology theory, or composition.

Three of the six units of electives must be in music literature or theory.

Prior to the beginning of the doctoral project and the thesis, the student must omplete the preliminary examination, which is administered by a committee ppointed by the Dean of the Graduate College.

Doctor of Philosophy in Musicology. The Doctor of Philosophy in Musicology is ntended for applicants whose interests lie in research in the history of music, heory of music, psychology of music, ethnomusicology, aesthetics, and the relation of music to social life and thought.

In addition to meeting the general requirements for admission to the Graduate College (see pages 20 to 25), an applicant must obtain the recommendation of the graduate committee of the School of Music in order to be admitted to this program. Applicants must (1) have completed work equivalent to that required by the School of Music of candidates for the Master of Music with a major in musicology or theory of music; (2) have acquired a background of approximately thirty-two semester hours in the liberal arts and sciences, including general history, philosophy, and literature; (3) be adequately prepared to pursue the doctoral program as determined by examinations administered by the graduate committee of the School of Music.

After admission to the doctoral program in musicology, the student must fulfill all requirements of the Graduate College pertaining to residence, number of units of graduate work, thesis, examinations, calendar, grades, major and minor fields, and foreign languages.

Eight of the sixteen units must be in Music 499 and are devoted to the completion of an original doctoral thesis. Admission to candidacy is recommended only after successful completion of the following:

(1) Sixteen units of graduate credit, or the equivalent, in courses including Music 321, 322, 414, 415, and 423. At least twelve of the sixteen units offered for graduate credit must be in the field of music. No more than two of the sixteen units may be in performance.

(2) In addition to the general foreign language requirements, proficiency in Latin is required. An examination in one or more additional foreign languages may be required when, in the opinion of the graduate committee, such ability is necessary for proper research in the student's field of concentration.

(3) A preliminary examination administered by a committee appointed by the Dean of the Graduate College.

Master of Science in Music Education. Candidates for this degree must earn a minimum of four units in music, two units in education, and two units in electives. The program must include one unit in music history and literature courses; one unit in music theory courses and one unit in music education courses including one-half unit in Foundations and Principles of Music Education, I. Required courses in education are Educational Psychology 311 and 312, one unit; and two courses selected from History and Philosophy of Education 301, 302, 303, 304, and 305, one unit. Electives may be in music, education, or another subject approved by the adviser. The grade-point average required for admission is 3.5. All applicants for admission are required to satisfy placement examinations in music history, music theory, and performance and literature in the principal music area. See pages 38 and 39.

Advanced Certificate in Music Education. The program leading to the Advanced Certificate in Music Education consists of a minimum of one year of work beyond the master's degree. The program is designed to provide advanced professional preparation for music educators. It is a terminal program and students who become candidates for the certificate are not considered as beginning work leading to the Doctor of Education with a major in music education.

Admission. A candidate for admission must hold a master's degree in music or

music education from an accredited institution and must have completed satisfactorily at least two years of professional employment in music education.

At the first registration, placement examinations are administered in music history, music theory, and applied music.

Residence. At least four units must be earned in residence on the Urbana campus. This requirement may be met by spending one full semester or two eight-week summer sessions in residence.

Program. A minimum of eight units beyond the master's degree is required. Music 440 and 441 and either Educational Psychology 411 or 412 are required. The remainder of the program is based upon the student's needs and interest and upon the deficiencies revealed in placement tests. No more than one unit of performance and literature may be counted toward the certificate.

Students who, at the time of first registration, do not hold a valid teaching certificate in music from the state in which they are employed are required to take courses sufficient to meet the certification requirements.

Doctor of Education. The program leading to the Doctor of Education with a major in Music Education is designed to provide advanced professional preparation for music educators and to develop educational leaders with a high level of musical, professional, and intellectual competence. The program is offered jointly by the School of Music and the College of Education.

Admission. A candidate for admission must hold a master's degree with a major in music education or the equivalent from an accredited institution. Admission is determined by examinations administered by the School of Music and the College of Education, personal interviews, record of previous education and experience, and recommendation from persons who have known the candidate. Examinations are administered by the School of Music in music education, music theory, music history, and applied music.

Applicants for admission should present credentials well in advance of their first registration. Admission is not complete until the candidate is accepted by two joint advisers, one from the School of Music and one from the College of Education.

Residence. Minimum residence requirements are two consecutive semesters during each of which a minimum of three units of work is successfully completed, or one semester during which a minimum of three units is successfully completed and the summer session immediately preceding or following during which a minimum of one and one-half units is successfully completed, plus an additional summer session during which a minimum of one and one-half units is successfully completed.

Program. At least sixteen units of work beyond the master's degree are required, including six units in music courses and six units in education courses. No more than two units of credit in applied music may be counted toward the degree.

The following courses are required: History and Philosophy of Education 410, Educational Psychology 415, Music 421, 440, and 441. The remainder of the program is planned for each candidate in terms of present and future professional needs and interests. For work completed elsewhere, see page 32. Extramural course work may not be included as part of this sixteen-unit requirement.

A thesis is required. It may be in the area of improving professional practice and may be a field study. No academic credit is granted for the thesis. General regulations of the Graduate College covering the filing of thesis title and the preparation, submission, and publication of theses must be met.

GRADUATE FACULTY

Professors: D. A. Branigan (Director of School of Music), J. L. Bailey, B. Bergethon, G. W. Binkerd, Dorothy E. Bowen, Dorothy E. Clark, H. A. Decker, C. DeLaney, P. S. Farrell, S. Fletcher, B. R.

FOOTE, L. T. FREDRICKSON, J. C. GARVEY, S. GOLDTHWAITE, B. M. GOODMAN, R. E. GRAY, R. J. HAMILTON, C. E. HAMM, M. H. HINDSLEY, G. H. HUNTER, B. JOHNSTON, H. KARP, K. KELLOGG, J. R. KELLY, COLLEEN J. KIRK, E. D. KISINGER, C. LEONHARD, A. J. MCDOWELL, J. H. MCKENZIE, B. NETTL, P. S. PETTINGA, CLAIRE L. RICHARDS, A. L. RINGER, P. ROLLAND, D. W. SANDERS, H. C. SCHMITT, H. O. SEXTON, S. STRAVINSKY, R. H. SWENSON, R. E. THOMAS, GRACE E. WILSON, L. E. ZIRNER.

Associate Professors: E. S. BERRY, A. M. CARTER, W. R. COGGINS, R. J. COLWELL, T. L. HOLDEN, E. J. KROLICK, R. B. MACDONALD, S. MARTIRANO, W. H. MILLER, P. PAINTER, R. B. SMITH, N. M. TEMPERLEY.

Assistant Professors: G. H. BEHAGUE, H. BRÜN, MARY M. BURDETTE, EVELYN REYNOLDS, A. R. THOMAS.

COURSES FOR GRADUATES

400. Advanced Instrumentation: Chamber and Symphonic. Orchestrate for chamber and symphony orchestras; works of classical, romantic, and modern composers. ½ or 1 unit. Prerequisite: Undergraduate instrumentation. KELLY.

401. Advanced Instrumentation: Band. Arrange for the concert band, works from orchestra, organ, and chamber music by composers of the classical, romantic, and modern periods. ½ or 1 unit. Prerequisite: Undergraduate instrumentation. HINDSLEY.

402. Analysis in Relation to Performance and Interpretation, I. A unifying course in the structure of music, in which analysis is related to the performance and understanding of music. Course material drawn from standard literature from the Renaissance to the present day with emphasis on the smaller forms. 1 unit. Prerequisite: Music 104 or equivalent; consent of instructor. LEONHARD.

403. Analysis in Relation to Performance and Interpretation, II. A unifying course in the structure of music, in which analysis is related to the performance and understanding of music. Course material drawn from standard literature from the Renaissance to the present day with emphasis on the larger forms. 1 unit. Prerequisite: Music 402. LEONHARD.

406. Composition. Advanced study of contrapuntal forms; study of contemporary melodic and harmonic practices; original work in advanced composition. ½ to 1½ units. COMPOSITION FACULTY.

410. History of Music Theory. 1 unit; maximum accumulated credit, 2 units. Prerequisite: Graduate standing in musicology or composition, or consent of instructor. HAMM.

411. Introduction to Ethnomusicology. A comprehensive survey of concepts, problems, and methods of research in non-Western and folk music. 1 unit. Prerequisite: Graduate standing in musicology or consent of instructor. NETTL.

412. History of Musical Aesthetics, I. A survey of the principal philosophies of music, their historical backgrounds, and their relation to musical styles. From Pythagoreanism to the humanistic period. ½ or 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Graduate standing in music. RINGER.

413. History of Musical Aesthetics, II. A survey of the principal philosophies of music, their historical backgrounds, and their relation to musical styles from the seventeenth century to the present day. ½ or 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Music 412. RINGER.

414. Notation, I. The history of notation from its beginning to 1400. ½ unit. Prerequisite: Consent of instructor. GOLDTHWAITE.

415. Notation, II. The history of notation from 1400 to 1600, including instrumental tablatures. ½ unit. Prerequisite: Music 414 or consent of instructor. GOLDTHWAITE.

416. History of Instrumental Music to 1600. A study of instrumental music from its beginnings in the Middle Ages to the end of the Renaissance. ½ or 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Music 312 or consent of instructor.

417. History of Instrumental Music from 1600 to 1750. A study of instrumental music in the Baroque era. ½ or 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Music 416 or consent of instructor. TEMPERLY.

418. The Origins and the History of Opera up to Gluck. The antecedents of opera in the sixteenth century; social, cultural, intellectual forces leading to its development; study of scores, librettos, scenography; readings on performance practices, theory, and aesthetics of opera. The principal composers covered are Monteverdi, Cavilli, Cesti, Lully, Rameau, Blow, Purcell, Scarlatti, Handel, Gluck. ½ or 1 unit. Prerequisite: Music 312 or consent of instructor. HAMM.

419. The History of Opera from Mozart to the Present. A detailed examination of stylistic and structural developments in opera after Gluck, with special reference to representative works from Mozart to Schoenberg viewed in relation to the general musical and cultural background of their time and place of origin. ½ or 1 unit. Prerequisite: Music 312 and 313, or consent of instructor. HAMM.

420. Seminar in Music Literature. Intensive study of outstanding works selected from all fields of music literature. Required of all students (except those in choral music) enrolled in the Doctor of Musical Arts program. 1 unit; maximum accumulated credit, 2 units. Prerequisite: Consent of instructor. GOLDTHWAITE.

421. Seminar in Music Education. An introduction to problems and methods of research in music education. Required of all candidates for the Doctor of Education in music education. 1 unit. Prerequisite: Graduate standing in music education or consent of instructor. BERGETHON.

422. Seminar in Theory of Music. Intensive study of selected topics in the fields of music theory, history of theory, and history of musical materials. ½ or 1 unit. Prerequisite: Grade standing in music theory or consent of instructor. LONDON.

423. Seminar in Musicology. Problems in historical and systematic musicology; discussions of special problems and reports on individual research. 1 unit. Prerequisite: Graduate standing in musicology and Music 321, or consent of instructor. STAFF.

424. Seminar in the Works of a Selected Composer. A seminar devoted to intensive historical and analytical study of the works of important composers. Each semester is devoted to one composer, e.g., Bach, Beethoven, Handel, Haydn, Mozart, Wagner, etc. 1 unit; S, ½ unit; may be repeated for a maximum of 2 units. Prerequisite: Music 213 and 214; two of the following: Music 310, 311, 312, 313, 315, or equivalent. STAFF.

428. Problems and Methods. An introduction to methods in research and stylistic criticism and to bibliographic aids, editions and editing of music, as related to the work of the musician and composer. Reports of bibliographic problems and on individual projects are presented orally and in writing. Required of all students in the Master of Music program, except those majoring in musicology. 1 unit. BEHAGUE, TEMPERLY.

429. Historical Studies in Twentieth-Century Music. A seminar in contemporary music, with emphasis on the historical foundations of current trends in musical

composition. ½ to 1 unit; maximum accumulated credit, 2 units. Prerequisite: Music 315, 422, or equivalent. RINGER.

430. **Advanced Orchestra Conducting and Literature.** Intensive study of conducting techniques and problems related to standard orchestral literature. Includes a survey of materials for school and community orchestra. 1 unit. Prerequisite: Previous conducting experience. GOODMAN.

431. **Advanced Band Conducting and Literature.** Study of problems and techniques of band conducting and a survey of literature for the concert band. 1 unit. Prerequisite: Bachelor's degree with major work or experience in band and/or orchestra; consent of instructor. HINDSLEY.

432. **Advanced Choral Techniques.** An intensive laboratory approach to the development of advanced techniques necessary for working effectively with choral ensembles. 1 unit. Prerequisite: Graduate standing in music. KIRK.

433. **Advanced Choral Literature and Conducting.** An intensive survey of choral literature with laboratory organization for reading, conducting, and interpretation of choral music of all periods, styles, and voice arrangements. 1 unit. Prerequisite: Graduate standing in music education, Music 432 or equivalent, or consent of instructor. DECKER, KIRK.

434. **Piano Literature.** 1 unit; maximum accumulated credit, 2 units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education, or consent of instructor. STRAVINSKY.

435. **Vocal Literature.** Study of solo song in larger works, and solo art song. 1 unit; maximum accumulated credit, 2 units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education, or consent of instructor. KELLOGG.

436. **Organ Literature.** An intensive study of organ literature from Bach to the present. The material includes the music itself, recordings, and collateral readings. 1 unit; maximum accumulated credit, 2 units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education, or consent of instructor. PETTINGA.

437. **String Instrument Literature.** 1 unit; maximum accumulated credit, 2 units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education, or consent of instructor. FARRELL.

438. **Wind Instrument Literature.** An integrating course offering the opportunity to survey at the graduate level the field of solo and ensemble wind literature. The material includes analysis and performance, when possible, of the music itself, recordings, and collateral readings. 1 unit; maximum accumulated credit, 2 units. KISINGER, WIND FACULTY.

439. **Percussion Instruments Literature.** An integrating course offering the opportunity to survey and analyze the field of solo and ensemble percussion literature. The material includes analysis and performance, when possible, of the music itself, recordings, and collateral readings. 1 unit; maximum accumulated credit, 2 units. Prerequisite: Graduate standing in music; consent of instructor. MCKENZIE.

440. **Foundations and Principles of Music Education, I.** A consideration of the historical and philosophical foundations of music education; the application of the principles of education to the music program. Major emphasis is placed on current trends in educational thought and their implications for music education. ½ or 1 unit. Prerequisite: Graduate standing in music education; consent of instructor. LEONHARD.

441. **Foundations and Principles of Music Education, II.** A consideration of the psychological foundations of music education; the application of the principles

of education to the music program. Major emphasis is placed on current trends in educational thought and their implications for instruction, supervision, administration, and evaluation in music education. ½ or 1 unit. Prerequisite: Graduate standing in music education; consent of instructor. LEONHARD.

442. The General Music Program in Secondary Schools. A detailed consideration of the general music program, its objectives, organization, and operation. Special attention is given to materials and methods of teaching. ½ or 1 unit. Prerequisite: Graduate standing in music education. LEONHARD.

443. Administration and Supervision of Music Education. Deals with the functions of supervisors and directors of music education in administering music programs in elementary and secondary schools. ½ or 1 unit. Prerequisite: Graduate standing in music or music education. BERGETHON.

444. The General Music Program in Elementary Schools. A detailed consideration of elementary general music, its objectives, organization, operation. Special attention is given to materials and methods of teaching. ½ unit. Prerequisite: Graduate standing in music education. BERGETHON.

445. Music in Higher Education. An orientation to the organization, teaching, and administration of music in the college and university. ½ or 1 unit. Prerequisite: Graduate standing in music or music education. BERGETHON.

446. Seminar in Experimental Music, I. Survey of contemporary electronic music, computer music and related types of music. Discussion of relevant music theory. ½ unit. Prerequisite: Music 303 or consent of instructor. BRÜN.

447. Seminar in Experimental Music, II. Continuation of Music 446. ½ unit. Prerequisite: Music 446 or consent of instructor. BRÜN.

450. History of Vocal Ensemble and Choral Music, I. A critical and analytic study of vocal and choral ensemble music from the Middle Ages to 1750. 1 unit; S, ½ unit. TEMPERLEY.

451. History of Vocal Ensemble and Choral Music, II. A critical and analytic study of vocal and choral ensemble music from 1750 to the present. 1 unit; S, ½ unit. TEMPERLEY.

480. Piano. ½ or 1 unit. Prerequisite: Bachelor of Music; successful completion of a qualifying examination given by the graduate committee. GRADUATE FACULTY.

481. Voice. ½ or 1 unit. Prerequisite: Bachelor of Music; successful completion of a qualifying examination given by the graduate committee. GRADUATE FACULTY.

482. Organ. Selected studies from the masterworks of organ literature. ½ or 1 unit. Prerequisite: Bachelor of Music; successful completion of a qualifying examination given by the graduate committee. GRADUATE FACULTY.

483. String Instruments. ½ or 1 unit. Prerequisite: Bachelor of Music; successful completion of a qualifying examination given by the graduate committee. GRADUATE FACULTY.

484. Wind Instruments. ½ or 1 unit. Prerequisite: Bachelor of Music; successful completion of a qualifying examination given by the graduate committee. GRADUATE FACULTY.

485. Percussion Instruments. ½ or 1 unit. Prerequisite: Bachelor of Music; successful completion of a qualifying examination given by the graduate committee. GRADUATE FACULTY.

489. Doctoral Projects. Special projects for candidates for the Doctor of Musical Arts. Open only to students in the Doctor of Musical Arts program. 1 to 8 units. Prerequisite: Consent of instructor. GRADUATE FACULTY.

499. **Thesis Research.** Research in special projects. 0 to 4 units. Prerequisite: Consent of instructor. GRADUATE FACULTY.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Eighteenth-Century Counterpoint.** The study of the technique of contrapuntal writing as found in the works of J. S. Bach and other eighteenth-century composers. Imitation, canon, invertible counterpoint, two- and three-part inventions, etc., are studied through writing and analysis of compositions by eighteenth-century composers. ½ unit. Prerequisite: Music 104 and/or consent of instructor. BINKERD, FREDRICKSON, HUNTER, KELLY.

301. **Fugue.** The study of fugal writing during the eighteenth and early nineteenth centuries. A continuation of the study of tonal counterpoint begun in Music 300, with special emphasis on the study and analysis of the fugal works of J. S. Bach, Handel, and Beethoven and on the writing of fugues and part fugues. ½ unit. Prerequisite: Music 300 and/or consent of instructor. BINKERD, FREDRICKSON, HUNTER, KELLY.

302. **Musical Acoustics, I.** A survey of basic topics in the physics of music: wave motion and the physical properties of sound; the ear and hearing; timbre, formant theory, and the acoustical properties of musical instruments. ½ unit. Prerequisite: Consent of instructor. HILLER.

303. **Musical Acoustics, II.** Acoustics, mathematics, aesthetics of pitch organization in music; scales, tuning, and temperament; pitch and rhythm, and their structural interrelationships; theories of perception of pitch and rhythm. ½ unit. Prerequisite: Music 302 and/or consent of instructor. HILLER.

304. **Contemporary Compositional Techniques.** Studies in specialized areas of composition for advanced undergraduates and graduates majoring in composition-theory. May be elected by others with consent of instructor. ½ unit. Prerequisite: Music 104, 106, 109, or consent of instructor. COMPOSITION FACULTY.

306. **Composition.** Work in original composition including the small and large homophonic forms. ½ or 1 unit. Prerequisite: Music 104 or 106, or consent of instructor. COMPOSITION FACULTY.

307. **Counterpoint of the Fifteenth and Sixteenth Centuries.** Analysis and writing in the principal contrapuntal styles of the fifteenth and sixteenth centuries. ½ unit. Prerequisite: Consent of instructor. BINKERD.

308. **Analysis of Musical Form.** An intensive study of representative compositions of the sixteenth through the twentieth centuries for structure and form. ½ unit. Prerequisite: Music 104 and 109, or consent of instructor. FARRELL.

310. **Ancient and Medieval Music.** A history of music from its origins to about 1400. ½ unit. Prerequisite: Music 131 or 214, or consent of instructor. MACDONALD.

311. **Music in the Renaissance.** A history of music from about 1400 to 1600. ½ unit. Prerequisite: Music 131 or 214, or consent of instructor. HAMM.

312. **Music of the Seventeenth Century.** A history of music from about 1600 to 1700. ½ unit. Prerequisite: Music 131 or 214, or consent of instructor. KELLMAN.

313. **Music of the Eighteenth Century.** A history of music from about 1700 to 1800. ½ unit. Prerequisite: Music 131 or 214, or consent of instructor. TEMPERLY.

314. **Music of the Nineteenth Century.** A history of music from about 1800 to 1900. ½ unit. Prerequisite: Music 131 or 214, or consent of instructor. MACDONALD.

315. **Music of the Twentieth Century.** A history of music from about 1900 to the present. ½ unit. Prerequisite: Music 131 or 214, or consent of instructor.

316. Introduction to Music of the World's Cultures. Same as Anthropology 316. An introduction to non-Western and folk music, to the role of music in the world's societies, and to the methods of collecting and studying music in non-literate, folk, and Asian high cultures. For students outside the School of Music. ½ unit. Prerequisite: Anthropology 103 or consent of instructor. NETTL.

317. Area Studies in Ethnomusicology. Same as Anthropology 315. A seminar devoted to intensive study in the music of one specific culture, e.g., (a) Japan (b) China, (c) Indonesia, (d) India, (e) the Near East, (f) African and New World Negro, (g) European and American folk cultures, (h) American Indian. ½ unit; maximum accumulated credit, 2 units. Prerequisite: Senior standing in music or consent of instructor. BEHAGUE, NETTL.

318. History of Performance Practices, I. The study of musical performance from about 900 to 1600. Discussion of musical instruments, makeup of instrumental and vocal ensembles, etc., are supplemented by demonstration performances of selected works using the University's collection of instruments. ½ unit. Prerequisite: Senior standing in music theory and music history or consent of instructor. HUNTER.

319. History of Performance Practices, II. The study of musical performance from 1600 to 1750. Discussion of musical instruments, ornamentation, basso continuo, etc., are supplemented by demonstration performances using the University's collection of instruments. ½ unit. Prerequisite: Senior standing in music theory and music history or consent of instructor. HUNTER.

320. Proseminar. Provides special preparation in specialized fields of musicology, music education, theory, and composition. ½ or 1 unit; maximum accumulated credit, 2 units. Prerequisite: Senior or graduate standing in music or music education; consent of instructor. GRADUATE FACULTY.

321. Proseminar in Musicology. A practical introduction to research in musicology devoted each time to intensive study of a selected topic, including the use of primary source materials, lectures, and reports. 1 unit; maximum accumulated credit, 2 units. Prerequisite: Graduate standing in musicology or consent of instructor. KELLMAN.

322. Introduction to Musicology. A survey of the various fields open to musicological research, both systematic and historical, with bibliographical studies and elementary problems for investigation. ½ or 1 unit; maximum accumulated credit, 2 units. Prerequisite: Senior or graduate standing in music, or consent of instructor. HAMM.

323. Opera Production, I. Designed to help interested students on the graduate level to study the problems of the lyric stage. Casting methods, program selection, production procedures, stage direction, coaching methods, and opera dramatics are investigated and practiced. ½ unit. Prerequisite: Music 265 and 381; consent of instructor. ZIRNER.

324. Opera Production, II. Designed to help interested students on the graduate level to study the problems of the lyric stage. Casting methods, program selection, production procedures, stage direction, coaching methods, and opera dramatics are investigated and practiced. ½ unit. Prerequisite: Music 323. ZIRNER.

329. History of Musical Instruments. The evolution of instruments, both Western and non-Western, considered in their social and cultural settings; construction and playing techniques of instruments treated in relation to performance practice and stylistic developments. ½ unit. Prerequisite: Music 213 and 214, or consent of instructor. NETTL.

340. **Applied Music Pedagogy.** A survey of techniques, practices, and materials; presentation of group and individual instruction; an approach to teaching problems, tone production, musical styles and interpretation for various age levels. Actual teaching experience under faculty supervision. Required of applied music majors in piano and string instruments. ½ unit; maximum accumulated credit, 1 unit. Prerequisite: Consent of instructor. BURDETTE, LYKE, MILLER, ROLLAND.

332. **Church Music Literature.** A survey of the development of church music with emphasis on the period since 1500. ½ unit. Offered in 1969-1970 and in alternate years. Prerequisite: Music 214 or 311, or consent of instructor. HAMILTON.

333. **Church Music Techniques.** The technical problems of the church musician: chanting, liturgical practices, organization, repertoire. ½ unit. Prerequisite: Music 332 or consent of instructor. HAMILTON.

334. **The Music of America, I.** A study of folk, popular, and art music in America from the time of the first European settlers through the middle of the nineteenth century; psalmody, early opera and concert life, African and European folk music, the singing school, music of European immigrants, and the roots of jazz. ½ unit. Prerequisite: Senior standing in music or consent of instructor. BEHAGUE.

335. **The Music of America, II.** A study of chamber, choral, and orchestral music written by American composers from 1850 to the present; jazz and its offshoots; folk and popular music, and experimental music in America. ½ unit. Prerequisite: Senior standing in music or consent of instructor. BEHAGUE.

336. **Music in Latin America.** Studies in the history of music in Latin America from colonial times to the present, including its cultural and social background. Each semester is devoted to a specific area, e.g., Caribbean America and Venezuela, Colombia and the Andean nations, Brazil and the River Plate nations. A reading knowledge of Spanish or Portuguese is recommended. ½ or 1 unit; maximum accumulated credit, 2 units. Prerequisite: Consent of instructor. BEHAGUE.

340. **Instrumental Clinic and Band Pageantry.** A study of the pecularities of the individual instruments, criteria for selection, and accepted teaching methods and procedures for each instrument. Band pageantry deals with formation designing, charting and show continuity, marching fundamentals, and special problems. ½ unit. Prerequisite: Advanced undergraduate or graduate standing, with major work or experience in band or orchestra. KISINGER.

341. **Advanced Instrumental Administration.** Administration of bands and orchestras in public schools and colleges. 1 unit. Prerequisite: Advanced undergraduate or graduate standing, with major work or experience in band or orchestra. KISINGER.

342. **Percussion Methods.** Designed primarily for teachers of school music who may or may not be percussion performers, but who wish to teach percussion and initiate such a program in the schools. ½ unit. Prerequisite: Senior or graduate standing in music education; Music 174 and 257, or equivalent. MCKENZIE.

343. **Tests and Measurement in Music Education.** Construction, design, appraisal, and use of measurement devices for music teaching and research. ½ or 1 unit. Prerequisite: Consent of instructor. COLWELL.

344. **Methods of String Class Teaching.** Designed primarily for teachers of school music who are not performers on a string instrument, yet would like to be able

to teach string classes and start an orchestral program in the schools. S; ½ unit. Prerequisite: Senior or graduate standing in music education or consent of instructor. D. MILLER.

345. **Teaching Techniques of Music Theory.** Teaching materials, methods, texts, and pedagogical sequence are discussed and analyzed, including an intensive survey of the structural materials normally covered during the first two years of collegiate study. ½ unit. Prerequisite: Music 300 or consent of instructor. CARTER.

346. **Workshop in Music Education.** Workshop designed to develop essential facts, attitudes, and principles through a consideration of problems encountered in music education. Parallel with this study is the preparation of resource materials for music programs in elementary and secondary schools. S; ½ or 1 unit; maximum accumulated credit, 2 units. Prerequisite: Senior or graduate standing in music education or consent of instructor. BERGETHON, LEONHARD, R. E. THOMAS.

347. **Teaching of Woodwind Instruments.** Designed primarily for teachers of instrumental music in the public schools. S; ½ unit. Offered in 1970 and in alternate years. Prerequisite: Senior or graduate standing in music education or consent of instructor. MCDOWELL, WOODWIND FACULTY.

348. **Teaching of Brass Instruments.** Designed primarily for teachers of instrumental music in the public schools. S; ½ unit. Offered in 1969 and in alternate years. Prerequisite: Senior or graduate standing in music education or consent of instructor. SEXTON, BRASS FACULTY.

349. **Music in Early Childhood.** Same as Home Economics 349. A detailed consideration of the music program in nursery schools, kindergarten, and the primary grades. Topics covered include the nature of early musical responses, objectives, and experience levels of the program, methods of teaching, and materials. Observation of music teaching in the Child Development Laboratory is included in the course work. ½ unit. Prerequisite: Senior or graduate standing in music education or child development. SMITH.

350. **Advanced Ensemble Music.** Selected projects in the study and performance of ensemble literature including the areas of operatic, instrumental, and vocal-choral literature and accompanying. ½ unit; S, ¼ unit. Prerequisite: Registration in applied music at the 300 level; consent of instructor. GARVEY, HUNTER, SWENSON, ZIRNER.

Applied Music

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

Private instruction on the advanced undergraduate and graduate level. Prerequisite: Completion of comparable course at the 100 level; qualifiying examination for transfer students.

377. **Class Piano (Advanced).** An integrated course in piano instruction with emphasis placed upon the acquisition of keyboard knowledges and skills essential for effective school music teaching; includes work in harmonization, transposition, improvisation, and vocal and instrumental score reduction. ½ unit. Prerequisite: Music 104, 109, 180, or consent of instructor. LYKE.

380. **Piano.** ½ or 1 unit; S, ¼ or ½ unit. FLETCHER, HEILES, KARP, RICHARDS, SANDER STRAVINSKY.

381. **Voice.** ½ or 1 unit; S, ¼ or ½ unit. BAILEY, BOWEN, BURDETTE, CLARK, CRAWFORD, FOOTE, KELLOGG, MILLER, REYNOLDS, G. WILSON.

382. Organ. ½ or 1 unit; S, ¼ or ½ unit. HAMILTON, PETTINGA.

383. Violin. ½ or 1 unit; S, ¼ or ½ unit. ROLLAND, SCHMITT.

384. Viola. ½ or 1 unit; S, ¼ or ½ unit. GARVEY.

385. Cello. ½ or 1 unit; S, ¼ or ½ unit. FARRELL, SWENSON.

386. String Bass. ½ or 1 unit; S, ¼ or ½ unit. KROLICK.

387. Flute. ½ or 1 unit; S, ¼ or ½ unit. DELANEY.

388. Clarinet. ½ or 1 unit; S, ¼ or ½ unit. COGGINS, MCDOWELL.

389. Oboe. ½ or 1 unit; S, ¼ or ½ unit. EDLEFSEN.

390. Bassoon. ½ or 1 unit; S, ¼ or ½ unit. BERRY.

391. Cornet and Trumpet. ½ or 1 unit; S, ¼ or ½ unit. SEXTON.

392. French Horn. ½ or 1 unit; S, ¼ or ½ unit. HOLDEN.

393. Trombone. ½ or 1 unit; S, ¼ or ½ unit. GRAY.

394. Baritone. ½ or 1 unit; S, ¼ or ½ unit. PERANTONI.

395. Tuba. ½ or 1 unit; S, ¼ or ½ unit. PERANTONI.

396. Percussion. ½ or 1 unit; S, ¼ or ½ unit. MCKENZIE.

397. Harp. ½ or 1 unit; S, ¼ or ½ unit. ROSENFIELD.

398. Saxophone. ½ or 1 unit; S, ¼ or ½ unit. COGGINS.

399. Harpsichord. ½ or 1 unit; S, ¼ or ½ unit. HUNTER.

NUCLEAR ENGINEERING

Nuclear engineering offers work leading to the Master of Science and Doctor of Philosophy and provides courses and research facilities for doctoral candidates in nuclear engineering and related fields.

The programs in nuclear engineering are open to all graduates in engineering, mathematics, and the physical sciences who have a grade-point average of at least 4.0 out of 5.0 for the last two years of undergraduate work. Students with grade-point averages below 4.0 but above 3.5 are considered individually. Applicants who fall in this latter category are invited to support their applications with a letter explaining the circumstances. It is recommended that they also submit letters of reference and information as to their rank in class.

Undergraduate courses in differential equations, advanced calculus, atomic physics, and nuclear physics are required as background for the nuclear engineering program. A student may be admitted before he has completed these four prerequisites, but he must then allow an additional semester or summer of study for completion of the master's degree.

The general requirements of the Graduate College must be met for either degree. A candidate for the M.S. degree who does not submit a thesis must complete nine units of graduate work.

A three-megawatt TRIGA Mark II reactor is located on campus for research and teaching in nuclear engineering. The reactor can be pulsed to power levels of 5,000 megawatts for special studies. Teaching facilities include a nuclear metallurgy laboratory, a radiochemistry and nuclear instrumentation laboratory, a boiling water heat transfer loop, several subcritical natural uranium assemblies, a waste disposal laboratory, a shielding laboratory, and a direct energy conversion laboratory.

For further information, see the brochure *Graduate Program in Nuclear*

Engineering, available from the Nuclear Engineering Office, 216 Nuclear Engineering Laboratory.

GRADUATE FACULTY

Professors: M. E. WYMAN (Chairman of Nuclear Engineering Program), F. T. ADLER, A. W. ALLEN, R. A. AXFORD, R. W. BOHL, A. P. BORES, B. T. CHAO, A. B. CHILTON, G. A. COSTELLO, B. B. EWING, L. GOLDSTEIN, C. D. HENDRICKS, J. P. HUMMEL, J. S. KOEHLER, H. H. KORST, R. J. MARTIN, M. S. MCVAY, G. H. MILEY, J. E. PEARSON, S. L. SOO

Associate Professors: J. H. AUSTIN, O. L. GADDY, D. F. HANG, B. G. JONES, J. T. VERDEYEN.

Assistant Professors: H. MERKELO, N. H. SCHILMOELLER, B. W. WEHRING.

COURSES FOR GRADUATES

401. Fundamentals of Nuclear Engineering. A lecture and problem course to provide background for further work in nuclear engineering. Problems in materials, heat transfer, and fluid flow. Special emphasis is given to basic ideas and the mathematical similarity of problems in heat transfer, fluid flow, and neutron diffusion. 1 unit. Prerequisite: Physics 282 or 382 and Mathematics 345, or equivalent, or consent of instructor.

411. Nuclear Reactor Heat Transfer. Selected topics in nuclear reactor heat transfer: thermal analysis of fuel elements under steady and transient operation, convective energy transport from reactor cores, two-phase flow and boiling in reactor cores, and liquid metal coolant systems. ¾ to 1 unit. Prerequisite: Nuclear Engineering 401 or consent of instructor.

421. Nuclear Concepts. Selected topics in low-energy nuclear physics of general interest to the nuclear engineering fields; nuclear reactions, cross sections, slowing down and interactions with matter, decay theory, and nuclear forces. 1 unit. Prerequisite: Physics 282 or 382; consent of instructor.

431. Nuclear Metallurgy. Metallurgical principles applied to materials problems in nuclear engineering, including topics in production of uranium, corrosion, radiation damage, fuel element fabrication, and fuel reprocessing. 1 unit. Prerequisite: Consent of instructor.

441. Nuclear Radiation Shielding. Radiation units and measurement; tolerance limits; interaction of radiation and matter; geometry factors in attenuation of gamma ray and neutron attenuation; moment theory for attenuation; application to reactors, protective shelters, and space vehicles. 1 unit. Prerequisite: Nuclear Engineering 347, Mathematics 343 and 345, or consent of instructor.

447. Radioactive Waste Disposal. Same as Civil Engineering 447. Sources and characteristics of radioactive wastes; methods of treatment; ultimate disposal; fate of radioisotopes in the environment; permissible levels in air and water; current levels in water supplies; water treatment methods; monitoring techniques; solid waste disposal; gaseous waste disposal; air monitoring; and reactor site selection and hazards evaluation. ½ or 1 unit. Prerequisite: Physics 282 or Chemistry or Nuclear Engineering 398, or consent of instructor.

451. Reactor Laboratory. Reactor operation: start-up, changes in power level, and shutdown. Reactor instrumentation: subcritical assemblies; flux measurements in core and thermal column; control rod worth measurements; effects of changes in fuel configurations; activation and neutron beam experiments. ½ or 1 unit. Prerequisite: Consent of instructor.

454. **Nuclear Engineering Laboratory Investigations.** Individual laboratory investigations in nuclear engineering. ½ to 1½ units. Prerequisite: Consent of instructor.

455. **Reactor Physics, I.** Same as Physics 455. An introduction to the physical concepts of reactor analysis; nuclear cross sections; diffusion, slowing down, and thermalization of neutrons; homogeneous reactor theory; introduction to heterogenous reactor theory and reactor kinetics; computer applications in reactor analysis. 1 unit. Prerequisite: Mathematics 343 and 345, Nuclear Engineering 347, or consent of instructor.

456. **Reactor Physics, II.** Same as Physics 456. Neutron transport theory; current methods of solution of the transport equation; fast and thermal neutron spectra; applications in heterogeneous reactor analysis and other areas of reactor physics; digital computer methods. 1 unit. Prerequisite: Nuclear Engineering 455 or consent of instructor.

458. **Nuclear Reactor Engineering.** Development of engineering design phases of the fission chain reactor: reactor materials and radiations, thermal aspects, heat removal, radiation hazards, shielding, reactor performance, controls and instrumentation, types and applications, fuel conversion, reactor power economics. 1 unit. Prerequisite: Consent of instructor.

460. **Reactor Kinetics.** Discussion of special topics such as response of reactor systems to changes of power demand and reactivity. Transfer function analysis, nonlinear problems of reactor dynamics, reactor stability; fuel cycles; digital and analog computer methods for solving reactor kinetic problems. 1 unit. Prerequisite: Nuclear Engineering 401 and 455, or consent of instructor.

467. **Thermomechanics of Nuclear Reactor Systems.** Same as Theoretical and Applied Mechanics 467. Origin of thermomechanics problems in nuclear reactor systems; heat generation and transfer in nuclear power systems; thermal stress in nuclear reactor systems; dynamical theory including effects of thermal shock and thermal stress-wave propagation; current thermomechanics problems in nuclear reactor design. Term paper required. 1 unit. Prerequisite: Nuclear Engineering 401 or consent of instructor.

490. **Special Topics.** Selected areas are considered which are of current interest in research, such as nuclear materials, advanced reactor systems, thermonuclear problems, digital computer methods in nuclear engineering, advanced topics in reactor theory. ½ or 1 unit. Prerequisite: Consent of instructor.

495. **Nuclear Engineering Problems.** Individual study in areas of nuclear engineering and closely related fields not covered by regular course offerings. The work is carried out under the supervision of a member of the staff. ½ to 2 units. Prerequisite: At least three units of graduate work; consent of instructor.

497. **Seminar in Nuclear Science and Engineering.** Lectures and discussions on current work in research and development in nuclear engineering and related fields by staff, advanced students, and visiting lecturers. No credit.

499. **Thesis Research.** 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

347. **Introduction to Nuclear Engineering.** Nuclear particles and nuclear chain reactions, energy release from fission; classification of nuclear reactors; fast and thermal reactors; reactor theory; slowing down and diffusion of neutrons; radiation shielding; materials of construction, radiation damage; reactor instrumentation, safety, and control; chemical processing of nuclear materials. ¾ or 1

unit. Prerequisite: Physics 282 or 382 and senior standing in engineering, or consent of instructor.

349. Fundamentals of Radiation Protection. Same as Civil Engineering 349. Principles and practice of health physics and radiation protection engineering, including such topics as: principles of dosimetry, sources of ionizing radiation; determination of radiation tolerances; dosimetric instruments; standards and regulations. ¾ or 1 unit. Prerequisite: Credit or reigstration in Nuclear Engineering 397 or Physics 382, or equivalent.

397. Radiochemistry. Same as Chemistry 397. Properties of radioactive nuclei, nature of radioactivity, nuclear structure, nuclear reactions, interactions of radiations with matter, chemical aspects of radioactivity work, and applications of nucleonics to chemistry. ¾ unit. Prerequisite: One semester of physical chemistry, or one semester of atomic physics, or consent of instructor.

398. Radiochemistry Laboratory. Same as Chemistry 398. Radioactivity detection and tracer applications of radioisotopes in chemistry and other fields. One laboratory and one discussion period per week. ½ unit. Prerequisite: One semester of physical chemistry, or one semester of atomic physics, or consent of instructor.

NUTRITIONAL SCIENCES

A graduate training program leading to the Master of Science and Doctor of Philosophy in Nutritional Sciences is offered under the auspices of an interdepartmental Committee on Nutritional Sciences. The degree requirements are designed to provide the basic knowledge of those disciplines (such as biochemistry, physiology and microbiology) which is necessary for conducting fruitful research in the broad field of the nutritional sciences, along with advanced training in an area of specialization. Emphasis in thesis research is placed on the study of metabolic processes pertaining to the nutrition of microorganisms, animals, and man.

In addition to the general requirements for admission to the Graduate College applicants are required to have a minimum grade-point average of 4.0 computed on the basis of the University grading system for the last sixty hours of undergraduate work. They also are expected to have sound basic courses in chemistry, biology, and mathematics. Applicants who are deficient in one or more of these subjects are expected to remove such deficiencies during their first year of graduate study.

Inquiries should be directed to: Director, Nutritional Sciences Program, 109 Mumford Hall.

PHILOSOPHY

The normal program of graduate study for philosophy majors is directed toward the Doctor of Philosophy. A limited number of students who wish to work for the Master of Arts alone are admitted. Graduate students majoring in other fields who wish to offer philosophy as a minor, or to include philosophy in their programs in a less formal way, are encouraged to consult with members of the graduate faculty in philosophy in order to plan appropriate courses of study.

Entrance Requirements.

Grade-Point Average. The normal requirement for admission is an average of 4.0 in the last sixty semester hours of work (or its equivalent). In special cases applicants are admitted with averages lower than 4.0, but in no case where the average is less than 3.75.

Preparatory Work. Each student should have had (1) a course in elementary logic, (2) a course in the theory of knowledge, (3) a course in ethics, and (4) a general course in the history of philosophy (the main figures of ancient and modern philosophy). Students with deficiencies in this regard are required to fill them by taking (1) Philosophy 102, (2) Philosophy 330 or 331, (3) Philosophy 321, or (4) Philosophy 303 and/or Philosophy 306, depending upon the student's particular deficiencies. Courses taken to fill such deficiencies may not be used to satisfy course requirements in the graduate program. No graduate credit is given for Philosophy 102, and a grade of A or B must be obtained.

Letters of Recommendation. All applications for admission only (as well as applications for admission and financial aid) must be supported by three letters of recommendation. The letters should be in each case from persons qualified to speak of the candidate's aptitude for graduate study in philosophy. Candidates are asked to have these letters transmitted directly to the Committee on Admissions and Financial Aid of the Department of Philosophy.

Graduate Record Examinations. All applicants for admission are likewise required to take the General Aptitude portion of the Graduate Record Examination and to have their scores transmitted to the department.

Master of Arts. Each student who has passed his preliminary examination for the Ph.D. is automatically qualified by the department to receive the A.M.

This degree may also be earned by completing one full year of residence study in philosophy at the University of Illinois (including six of the eight units required for the degree), submitting a substantial essay, and passing an oral examination on the essay given by a committee appointed by the Chairman of the Department. A degree earned in this way is normally a terminal one.

Doctor of Philosophy. In the preliminary examination, required of all candidates for this degree, each student is required to demonstrate a basic competence in the following four broad areas of philosophy: (1) history of philosophy, (2) theory of knowledge, (3) metaphysics, and (4) ethics and value theory.

Candidates for this degree are not generally required to offer work in a minor field outside the department. However, where a student's advanced study in philosophy would be strengthened by the inclusion of work in a related field, he may be advised to include such work in the courses taken to satisfy the requirements for the degree. The amount of such work is limited to two units, unless the student wishes the work to count as an extra-departmental minor. Then the minimum work accepted is two units, the maximum four.

Prior to taking the preliminary examination each candidate is required to demonstrate a basic competence in mathematical logic. This may be done by passing an approved course in the subject or passing a proficiency examination administered by the department.

Subsequent to the preliminary examination the student must submit an acceptable dissertation in one of the above four areas of philosophical research and pass a final examination on the dissertation. The acceptability of the dissertation is judged, and the final examination administered, by the student's doctoral committee.

A more detailed description of the graduate program in philosophy may be secured from the Department of Philosophy, 105 Gregory Hall.

GRADUATE FACULTY

Professors: B. J. Diggs (Chairman of Department), C. E. Caton, A. H. Donagan, D. S. Shwayder, A. R. Turquette, F. L. Will.

Associate Professors: H. S. Chandler, R. C. Stalnaker, H. M. Tiebout, J. D. Wallace.

Assistant Professors: R. N. Faber, P. G. Hugly, F. W. Neely, R. L. Schacht, F. R. Suppe, J. J. Valberg.

COURSES FOR GRADUATES

401. Seminar in Ancient Philosophy. 1 unit. May be repeated for credit.

403. Seminar in Medieval Philosophy. 1 unit. May be repeated for credit.

405. Seventeenth-Century Continental Thought (Descartes, Spinoza, Leibniz). A study of the basic philosophical works of the three leading continental thinkers of the century. 1 unit. May be repeated for credit.

407. British Empiricism. 1 unit. May be repeated for credit.

408. Seminar in Kant. 1 unit. May be repeated for credit.

409. Recent American Philosophy. Major American philosophers and movements since about 1900. Reports and discussions. 1 unit. May be repeated for credit.

410. Seminar in Nineteenth-Century Philosophy. 1 unit. May be repeated for credit.

411. Seminar in Recent Ethical Theory. 1 unit. May be repeated for credit.

412. Seminar in Social Philosophy. A seminar designed to study special problems in social philosophy. Particular attention is given to the contributions of the social sciences to social philosophy. To be offered with varying topics. 1 unit. May be repeated for credit. Diggs.

413. Logical Theory. 1 unit. Prerequisite: A course in logic or consent of instructor. May be repeated for credit.

415. Seminar in Metaphysics. Intensive study of a selected topic of major importance in the field of metaphysics. 1 unit. May be repeated for credit.

417. Seminar in the Philosophy of Science. Various problems arising from specific studies in philosophy pertaining to science and vice versa. To be offered with varying topics. 1 unit. May be repeated for credit.

420. Seminar in Semantics. Same as Communications 420. Intensive study of important contemporary contributions in the fields of semantics, analytic philosophy, and the philosophy of language. 1 unit. May be repeated for credit.

421. Seminar in Contemporary Problems. Intensive study of selected problems or topics in contemporary philosophy, with particular emphasis on questions of knowledge and value. 1 unit. May be repeated for credit.

423. Seminar in the Theory of Knowledge. Selected topics and writings of major importance in the contemporary philosophy of knowledge. 1 unit. May be repeated for credit.

424. Seminar in the Theory of Knowledge. Selected topics and writings of major importance in the contemporary philosophy of knowledge. 1 unit. May be repeated for credit.

425. Seminar in the Philosophy of Mind. Selected topics from major writings in the philosophy of mind. 1 unit. May be repeated for credit.

430. Seminar in Modern Aesthetics. 1 unit. May be repeated for credit.

439. Seminar in the Philosophy of Mathematics. Detailed examination of important questions arising from philosophical and logical analyses of mathematics. 1 unit. May be repeated for credit. Prerequisite: Consent of instructor.

483. Individual Topics. Individual study and oral written reports on topics not covered in other courses. Not more than one unit may be counted toward the A.M. degree and not more than two toward the Ph.D. degree. Topics and plan

of study must be approved by the candidate's adviser and by the staff member who directs the work. ½ to 2 units. STAFF.

499. Thesis Research. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. History of Greek and Roman Philosophy. 1 unit.

304. History of Medieval Philosophy. Lectures and reading in the history of philosophy from St. Augustine to William of Ockham. ¾ or 1 unit. Prerequisite: Philosophy 101 or 303.

306. History of Modern Philosophy. 1 unit.

307. History of Modern Philosophy. Bacon, Hobbes, Locke, Berkeley, Hume. Philosophy 307 and 308 taken concurrently in the summer session are the equivalent of Philosophy 306. S; ½ unit. Prerequisite: Consent of instructor.

308. History of Modern Philosophy. Descartes, Spinoza, Leibniz, Kant. Philosophy 307 and 308 taken concurrently in the summer session are the equivalent of Philosophy 306. S; ½ unit. Prerequisite: Consent of instructor.

309. The Philosophy of Plato. ¾ or 1 unit. Prerequisite: Philosophy 101 or 303.

310. The Philosophy of Aristotle. An intensive study of major works of Aristotle or of some aspect of his philosophy. 1 unit. Prerequisite: Philosophy 101 or 303.

311. Philosophic Ideas of the Nineteenth Century. ¾ or 1 unit. Prerequisite: One course in philosophy (preferably Philosophy 101 or 306).

312. The Philosophy of Kant. An intensive study of the major works of Kant, and in particular, of the *Critique of Pure Reason*. ¾ or 1 unit. Prerequisite: One course in philosophy.

313. American Philosophy. The history of philosophy in America from colonial times to the present. ¾ or 1 unit. Prerequisite: One course in philosophy. FISCH.

317. Great Books in Modern Thought. Hume, Darwin, Marx, Freud. Reading and discussion of selected books which either have produced or themselves reflect in some important way a changed conception of man and the world. ¾ or 1 unit. Prerequisite: One course in philosophy.

319. Philosophical Ideas in Latin America. A survey of the main philosophical currents and thinkers of Latin America. ½ or 1 unit. Prerequisite: One course in philosophy.

321. Ethics and Value Theory. ¾ or 1 unit. Prerequisite: One course in philosophy.

322. Recent Developments in Ethics. Ethical theories of the last fifty years; intuitionism, naturalism, pragmatism, emotivism, existentialism, analytic ethics. ¾ or 1 unit. Prerequisite: Philosophy 103, 105, or 321.

323. Philosophy of Art. A discussion of the main philosophical principles of art and of outstanding contemporary philosophies of art. ¾ or 1 unit.

324. Philosophy of Religion. ¾ or 1 unit. Prerequisite: One course in philosophy.

325. Philosophy of Mind. Philosophical problems arising in connection with mental phenomena; the relation of mind and body; free will and determinism; our knowledge of other minds; the self and personal identity. ¾ or 1 unit. Prerequisite: One course in philosophy.

326. Metaphysics. ¾ or 1 unit. Prerequisite: One course in philosophy.

327. Scientific Method. Methodology and epistemology; empirical knowledge and learning from experience; science and common sense; scientific explanation;

historical examples; generalizing and historical science; natural and social science historicism; explanation in the social sciences. ¾ or 1 unit.

328. **Philosophy of Science.** A study of some philosophical problems that have developed from modern science. ¾ or 1 unit. Prerequisite: One course in philosophy.

330. **Theory of Knowledge.** The relative acceptability of authority, intuition, and the method of hypothesis as ways of establishing belief; logical and empirical truth; pragmatism and positivism; other selected contemporary topics. ¾ or 1 unit. Prerequisite: One course in philosophy.

331. **Analytic Philosophy.** Advanced treatment of problems of knowledge and method and introduction to contemporary techniques of philosophical analysis. Meaning and verification; inductive and deductive method; perceptual knowledge; certainty; other selected topics. ¾ or 1 unit. Prerequisite: One course in philosophy.

332. **Perception and Knowledge.** A systematic study of basic problems in the philosophy of perception: perceiving as a mental state; the objects of perception; sensing, sensation, and sense-data; perception and the external world; perception as the basis of empirical knowledge. Traditional empiricist philosophies of perception are examined and contemporary criticisms and defenses are assessed. ¾ or 1 unit. Prerequisite: One course in philosophy.

333. **Symbolic Logic.** A study of the elementary principles of symbolic analysis as applied to logical problems. ¾ or 1 unit. TURQUETTE.

334. **Symbolic Logic.** A general study of the more refined methods of symbolic analysis as applied to logical problems. Particular attention is devoted to proof procedures as they relate to the question of consistency and completeness. ¾ or 1 unit. Prerequisite: Philosophy 333. TURQUETTE.

335. **Social Philosophy.** The nature of social organization as seen from economic, moral, and political standpoints; various senses of freedom; relations between organization and freedom; the free society. ¾ or 1 unit. Prerequisite: One course in philosophy.

336. **Philosophy of Law and of the State.** ¾ or 1 unit. Prerequisite: One course in philosophy.

337. **Semantics.** An investigation of semantical concepts such as denoting and truth; study of the functions of language, definition, meaning and verification, semantical paradoxes. ¾ or 1 unit. Prerequisite: A course in logic.

338. **Philosophies of Language.** Same as Linguistics 338. A study of the development of philosophical problems about language and the treatment of them from antiquity through the nineteenth century. ¾ or 1 unit. Prerequisite: One course in philosophy.

339. **Philosophy of Mathematics.** Introduction to some of the main philosophical problems and contemporary viewpoints concerning mathematical concepts, mathematical methods, and the nature of mathematical truths. The concept of infinity; conventionalism and formalism; the distinction between analytic and synthetic truths; necessity; mathematics and the problem of universals; other related topics. ¾ or 1 unit. Prerequisite: One course in philosophy.

340. **The Philosophy of Alfred North Whitehead.** An examination of the mature thought of A. N. Whitehead, primarily as contained in *Process and Reality* and *Adventures of Ideas,* taking into account both the cosmological scheme and the application of his technical philosophy to social philosophy, to ethics, and to philosophy of religion. ¾ or 1 unit. Prerequisite: One course in philosophy.

341. **Existential Philosophy.** A study of a selection of the major writings of the more important existential philosophers, e.g., Heidegger, Jaspers, Sartre. ¾ unit

Prerequisite: One course in philosophy (preferably Philosophy 311) or consent of instructor.

343. **Phenomenology.** A study of the development of phenomenology from Husserl to the present. ¾ or 1 unit. Prerequisite: One course in philosophy.

350. **Philosophy and Modern Life.** A study of the relation between philosophy and contemporary life, including an analysis and discussion of the philosophical principles involved in the artistic, intellectual, cultural, and social developments of the modern world. ¾ or 1 unit. Prerequisite: One course in philosophy.

353. **Metamathematics, I.** Formal mathematical systems and their semantics: sentential, first-order predicate calculus, predicate calculus with identity; formal semantics and model theory of these systems, consistency and completeness theorems; Gödel completeness theorem, Löwenheim-Skolem theorem, compactness theorem. Intended primarily for philosophy majors. 1 unit. Prerequisite: Philosophy 102, or graduate standing, or consent of instructor.

354. **Metamathematics, II.** A continuation of Philosophy 353. Elementary arithmetics; Craig's theorem and Beth definability results; arithematization, recursive enumerability, recursive functions; Church's thesis; Church's theorem; Gödel incompleteness theorems and their extensions; Tarski's truth theorem; alternative approaches to recursive function theory; selected additional topics. Intended primarily for philosophy majors. 1 unit. Prerequisite: Philosophy 353 in the previous semester, or consent of instructor.

361. **Comparative Religions: The Religions of the East.** A comparative philosophical analysis of the philosophic doctrines and the mythologies of Hinduism, Buddhism, and Taoism, with incidental reference to Jainism, Sikhism, Confucianism, and Shinto. ¾ or 1 unit. Prerequisite: One course in philosophy. TIEBOUT.

362. **Comparative Religions: The Religions of the West.** A comparative philosophical analysis of the philosophic doctrines and religious symbols of Judaism, Christianity, and Islam. ¾ or 1 unit. Prerequisite: One course in philosophy. TIEBOUT.

363. **Contemporary Religious Thought.** An analysis of contemporary philosophical developments in Judaism, Christianity, and Islam, with particular emphasis upon "Neo-orthodox" Protestant thought. ¾ or 1 unit. Prerequisite: One course in philosophy. TIEBOUT.

PHYSICAL EDUCATION

The department offers graduate programs leading to the Master of Science emphasizing increased scholarly research competence, the Master of Science in the Teaching of Physical Education, emphasizing increased teaching competence, and the Doctor of Philosophy, emphasizing advanced scholarly research in one of three closely related areas, namely: physical education, health and safety education, or recreation and park administration.

Master of Science. The admission requirements for a major are: (1) a minimum grade-point average of 4.0 (b) for the last sixty semester hours of undergraduate study (applicants whose averages are below 4.0 but above 3.75 are considered on an individual basis); (2) thirty semester hours of approved undergraduate credit in physical education, including a course in tests and measurements; (3) eighteen semester hours of undergraduate credit in science; (4) sixteen semester hours of undergraduate credit in education; (5) acceptable scores on the Miller Analogies Test and on the aptitude part of the Graduate Record Examination; and (7) approval of the Graduate College.

Candidates for this degree must complete eight units including: (1) four units in physical education, including Physical Education 495; (2) two approved units in another discipline directed toward a specific research interest; (3) Physical Education 490, one semester, no credit; and (4) thesis, two units.

Master of Science in the Teaching of Physical Education. The Master of Science in the Teaching of Physical Education is primarily an advanced program for increasing teaching proficiency. (See Table of Contents for information relative to the requirements for Teacher Certification.) The admission requirements are identical with those for the Master of Science in Physical Education.

Candidates for this degree must complete eight units including: (1) four units in physical education or approved related courses, including Physical Education 495; (2) two units in education, including Educational Psychology 311 and 312 and two of the following: History and Philosophy of Education 301, 302, 303, and 304; (3) Physical Education 490, one semester, no credit; and (4) thesis, two units. The thesis requirement may be waived upon approval of a petition, but the student must substitute two additional units of course work and pass a comprehensive examination.

Doctor of Philosophy. This program permits specialization in one of three related areas: physical education, health and safety education, or recreation and park administration.

The admission requirements for each major area are: (1) those outlined for admission to the program for the master's degree; (2) completion of work for the master's degree with a high level of achievement; (3) approval of the head of the department concerned (contingent upon interviews, various test scores, written recommendations, etc.); and (4) approval of the Graduate College.

Candidates for this degree must complete a minimum of twenty-four units of credit, including the following: (1) a minimum of eight units in the major or related fields (physical education, health education, or recreation); (2) one minor for a minimum of four units, or two minors for a minimum of two units each (in both cases outside the major and related fields); (3) ability to translate accurately two foreign languages, or ability to read, write, and converse satisfactorily in one foreign language, or two additional approved graduate course units may be substituted for each of the two foreign languages; (4) a seminar, 490, in the major field; and (5) completion of an acceptable dissertation.

GRADUATE FACULTY

Professors: R. G. Wright (Head of Department), Alyce T. Cheska, T. K. Cureton, Jr., A. W. Hubbard, Laura J. Huelster, D. O. Matthews, K. J. McCristal, R. H. Pohndorf, R. E. Shelton, E. F. Zeigler

Associate Professors: Phyllis Hill, W. Johnson, R. J. Keller, G. Luescher, A. C. Moore, Jr., Evelyn Schurr, Marianna Trekell, Olive C. Young.

Assistant Professors: B. D. Franks, Nell C. Jackson, J. E. Razor, B. L. Rothermel.

COURSES FOR GRADUATES

401. **Administration of Physical Education and Sport.** Analysis of completed research relating to theory and practice of administration in physical education and sport; the development of policy statements and procedures manuals for the various educational levels; experience in the use of the case plan of instruction as a teaching technique for the development of competence and knowledge relating to human relations and administration in this specialized

field. 1 unit. Prerequisite: Physical Education for Men or Physical Education for Women 204 or equivalent. HUELSTER, MATTHEWS, WRIGHT, ZEIGLER.

302. History of Physical Education and Sport. An analysis of the research literature related to the historical foundations of physical education and sport; discussion of such persistent historical problems as the influence of economics, politics and nationalism, curriculum and methods of instruction, professional preparation, the healthy body, dance, the use of leisure, and amateur and professional sport. 1 unit. Prerequisite: Physical Education for Men or Physical Education for Women 209 or equivalent. TREKELL, ZEIGLER.

306. Philosophy of Physical Education and Sport. Philosophical analysis of physical education and sport (with some reference to school health and recreation) in the light of the leading philosophical tendencies and possible implications for public and private education; analysis of completed research; includes delineation of one's personal philosophy and the use of philosophical analysis as a research technique. 1 unit. Prerequisite: Philosophy 101; History and Philosophy of Education 305. HUELSTER, ZEIGLER.

407. Sport Psychology. Analysis of psychological factors and principles with special reference to motor performance, learning motor skills, perception and emotion in sports situations; review of literature; independent projects. 1 unit. Prerequisite: Psychology 100; Educational Psychology 211; consent of instructor. HUBBARD, YOUNG.

408. Principles of Kinesiotherapy. Analysis of medically approved techniques employed in the treatment of disease and injury by exercise and movement; kinesiological evaluation of principles involved; therapy preparation in teaching techniques; medically prescribed clinical training; literature; research. 1 unit. Prerequisite: Anatomy, physiology, kinesiology, and physiology of exercise, or consent of instructor. SHELTON.

451. Scientific Foundations of Physical Fitness. Scientific basis for physical fitness; analysis of fitness programs and fitness tests; techniques in remedial clinics; literature; research. Includes laboratory session. 1 unit. Prerequisite: Undergraduate anatomy and physiology, tests and measurements. CURETON, POHNDORF.

452. Scientific Analysis of Physical Education Activities. Analysis of selected activities in terms of physiological, anatomical, physical mechanics, and kinesiological features, involving both cinematographical and metabolic methods. Includes laboratory session. 1 unit. Prerequisite: Anatomy, physiology, kinesiology, elementary physics, algebra, and trigonometry, or consent of instructor. CURETON.

453. Anthropometrical and Body Mechanics Research Techniques. Critical analysis of the techniques of anthropometrical and body mechanics measurements; analysis of selected research studies; laboratory and computational projects in biophysical study. 1 unit. Prerequisite: College algebra and trigonometry; Physical Education 495 and 451. CURETON.

490. Seminar. Lectures, discussions, and critiques on physical education and related subjects by faculty members and visiting professional leaders; presentation and criticism of student theses. No credit. STAFF.

493. Special Projects. Independent research on special projects. Offered summers as special group practicums. ½ or 1 unit. STAFF, VISITING FACULTY.

495. Techniques of Research in Health, Physical Education and Recreation. Review and appraisal of common research procedures; application of statistical procedures, library methods, evaluation procedures, and experimental methods. 1 unit. HUBBARD, POHNDORF, TREKELL.

499. Thesis Research. Preparation of theses in physical education. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

302. Problems of Facilities Planning, Construction, and Utilization. Physical education facilities as related to objectives of physical education; consultant services with planning committees and architects; cost factors in different types of construction; the use of standards as a check on and guide for planning; safety factors; changes in playing surfaces due to research; building and field maintenance problems. ½ unit. Prerequisite: Physical Education for Men or Physical Education for Women 204 or equivalent, or consent of instructor. KELLER.

303. International Physical Education and Sport. A study of objectives, methods, personnel, facilities, and evaluation of selected national programs of physical education. Additional consideration is given to sports clubs, indigenous games, and research. ½ unit. Prerequisite: Physical Education for Men or Physical Education for Women 209, or consent of instructor. JOHNSON.

350. Theory and Practice of Exercise Therapy. Theory and practice of therapeutic exercise as it applies to physical rehabilitation of the physically handicapped; physiological and kinesiological principles of physical restoration; the physical educator's role as related to ancillary medical forces; problems and principles related to kinesiotherapy, preventive, adapted, and remedial physical education and athletic training. 1 unit. Prerequisite: Anatomy, physiology, physiology of exercise, and kinesiology; or consent of instructor. SHELTON.

PHYSICAL SCIENCES

A special program leading to the Master of Science in the Physical Sciences is available to meet the needs of secondary school teachers who wish to get a broad view of the physical sciences rather than to specialize in one department. Since the program is designed primarily for those preparing to teach the physical sciences, chemistry and physics are emphasized. Students working toward degrees under the provisions of this program are expected to seek approximately equal proficiency in both physics and chemistry; those whose undergraduate work has emphasized chemistry should balance this by weighting the graduate work in favor of physics, and vice versa. No thesis is required, and all courses in physics, chemistry, geology, astronomy, and mathematics which normally give graduate credit are acceptable toward the degree. To qualify for the degree, a student must present at least one course in mathematics beyond calculus, for which calculus is prerequisite. In addition, he must have met the requirements for teacher certification.

Candidates for the Master of Science in the Teaching of the Physical Sciences, which is distinct from the program described above, must earn four units in the physical sciences, two units in education, and two units in electives. The two units in education must include the following courses: History and Philosophy of Education 304 and 305, one unit; and Educational Psychology 311 and 312, one unit. The courses in the physical sciences and the electives—which must normally give graduate credit—must be selected with the approval of the adviser. The electives may be in the physical sciences, in education, or, in exceptional cases, in other fields. Students applying for admission must have a grade-point average of at least 3.5. See pages 38 and 39.

Inquiries concerning these programs should be directed to Professor D. H. Secrest, 155 Noyes Laboratory.

PHYSICS

The Department of Physics offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy in Physics.

There is opportunity for specialization in atomic and nuclear physics, including research with the betatrons, the cyclotron, and with radioactive sources; in nuclear magnetic resonance; in theoretical physics; in the physics of solids, including research on ionic crystals, metals, semiconductors, cryogenics, and surface physics; in plasma physics and aeronomy.

Requirements for admission to the Graduate College with a major in physics are twenty semester hours of physics, including Physics 321, 341, and 342, or the equivalent, and excluding courses in general physics, and an average of at least 3.75 for the last sixty hours of undergraduate work. Advanced undergraduate courses in light, thermodynamics, and atomic physics are strongly recommended.

The requirements for the Master of Science in Physics are the general requirements of the Graduate College. They may be satisfied by adequate performance in graduate courses, without the submission of a thesis.

Departmental requirements for the Doctor of Philosophy in Physics, in addition to the general requirements of the Graduate College, are described in a pamphlet which may be obtained from the office of the head of the department.

Candidates for the Master of Science in the Teaching of Physics must earn four units in physics; two units in approved electives; Educational Psychology 311, 312, and one additional unit in education selected from History and Philosophy of Education 301, 302, 303, and 304. Students applying for admission must present an average of 3.75 for the last sixty hours of undergraduate work; applications of students with averages below 3.75 but above 3.5 are considered on an individual basis. The adviser for candidates for this degree is Professor G. M. Almy, 209 Physics Building. See pages 38 and 39.

For information concerning applied mathematics, see page 307; for information about biophysics, see pages 102, 281, and 285. A doctoral program in chemical physics is described on page 118.

GRADUATE FACULTY

Professors: G. M. Almy (Head of Department), A. Abashian, F. T. Adler, J. S. Allen, D. Alpert, G. Ascoli, P. Axel, J. Bardeen, G. A. Baym, F. C. Brown, R. M. Brown, M. K. Brussel, W. D. Compton, C. P. Flynn, L. D. Fosdick, H. Frauenfelder, D. M. Ginsberg, A. V. Granato, P. Handler, A. O. Hanson, J. P. Hummel, L. P. Kadanoff, J. S. Koehler, L. J. Koester, P. G. Kruger, U. E. Kruse, L. S. Lavatelli, D. Lazarus, E. M. Lyman, D. E. Mapother, R. J. Maurer, B. H. McCormick, J. R. Pasta, D. Pines, M. Raether, D. G. Ravenhall, C. S. Robinson, G. A. Russell, C. T. Sah, R. D. Sard, C. B. Satterthwaite, R. O. Simmons, C. P. Slichter, J. H. Smith, J. N. Snyder, A. Wattenberg, H. W. Wyld, Jr., M. E. Wyman, A. I. Yavin.

Associate Professors: A. C. Anderson, J. H. Cahn, P. G. Debrunner, S. Ichimaru, E. A. Jackson, M. V. Klein, T. A. O'Halloran, R. N. Peacock, F. M. Propst, H. J. Stapleton, D. C. Sutton, W. S. Williams.

Assistant Professors: B. I. Eisenstein, L. E. Holloway, W. E. Massey, J. M. Mochel, M. B. Salamon, R. L. Schult, J. D. Stack, J. D. Sullivan, J. S. Trefil, M. Wortis, J. A. Wright.

COURSES FOR GRADUATES

400. Problems and Methods of Mathematical Physics. Matrices and tensors; analytic functions of a complex variable; conformal mapping; contour integration; ordinary differential equations: solutions at singular points, contour integral solutions, asymptotic expansions; eigenfunctions and eigenvalues; partial differential equations: Laplace's equation, wave equation, diffusion equation, Green's functions; Legendre, Bessel, confluent hypergeometric, Mathieu, and elliptic functions; elementary difference equations. 1 unit. Prerequisite: Mathematics 342, 345, 347, or 387; Physics 322 and 342; or consent of instructor.

422. Dynamics and Nonlinear Mechanics. Hamiltonian mechanics: Lagrange equations, Hamilton's canonical equations, contact transformations, Lagrange and Poincaré invariants, Hamilton-Jacobi equation and Huygens' principle; perturbation theory, relaxation oscillations and stability of periodic motion, theory of cosmotron orbits, three-body problems. 1 unit. Prerequisite: Physics 322; Mathematics 345.

424. Relativity and Cosmology. Same as Astronomy 424 and Mathematics 460. Elements of tensor calculus and Riemannian geometry; special relativity: Lorentz transformations, equivalence of mass and energy; general relativity and the gravitational field of the sun; galaxies and cosmology. 1 unit. Prerequisite: Consent of instructor.

435. Theory of Semiconductors and Semiconductor Devices. Same as Electrical Engineering 435. Introductory quantum mechanics of semiconductors; energy bands; dynamics of Bloch electrons in static and high frequency electric and magnetic fields; equilibrium statistics; transport theory, diffusion, drift and thermoelectric effects; characteristics of p-n junctions, heterojunctions and transistor devices. 1 unit. Prerequisite: Physics 381 or 383.

436. Selected Topics in Physics of Solids. The following topics are offered in rotation, one or two each semester.

(a) Imperfections in Metals. Influence of point imperfections such as lattice vacancies and interstitial atoms on diffusion and on such physical properties as resistivity, stored energy, lattice parameter, density; properties of dislocations and stacking faults and their influence on mechanical properties, on physical properties, on crystal growth, and on phase changes. 1 unit. Prerequisite: Physics 490.

(b) Imperfections in Ionic Crystals. Theory of vacancies, interstitial ions, dislocations, and excitons; applications to diffusion, ionic conductivity, chemical reactions in the solid state, and plastic flow; effect of imperfections upon the electronic and optical properties of ionic crystals. 1 unit. Prerequisite: Physics 490.

(c) Magnetic Properties of Solids. Quantum theory of diamagnetism, paramagnetism, ferromagnetism; elements of magnetic resonance and relaxation. 1 unit. Prerequisite: Physics 482 and 490, or consent of instructor.

441. Electrodynamics. Electrostatics; Laplace's and Poisson's equations; boundary value problems; spherical harmonics; multiple potentials; dielectrics; microscopic and macroscopic fields; electric susceptibility; magnetostatics; magnetic multipoles; magnetic media; conducting media; Maxwell's equations; field energy and momentum; electromagnetic waves; reflection and refraction; dispersion; wave packets; causality; diffraction; wave guides and cavity resonators; simple aspects of magnetohydrodynamics and plasmas. 1 unit. Prerequisite: Physics 342 or equivalent; registration in Physics 500 or consent of instructor.

442. Electrodynamics. Special theory of relativity; covariant formulation of electrodynamics; charged particle dynamics; high energy particle accelerators; energy loss by charged particles traversing matter; multiple scattering; Lienard-Wiechert potentials; radiation by charged particles; radiation loss in particle accelerators; Thomson scattering; bremsstrahlung; Weiszacker-Williams method; inner bremsstrahlung; Cerenkov radiation; radiative reaction; natural line breadth; multiple expansion of radiation field; Lagrangian and Hamiltonian formulation of electrodynamics. 1 unit. Preresquisite: Physics 441.

455. Reactor Physics, I. Same as Nuclear Engineering 455. An introduction to the physical concepts of reactor analysis; nuclear cross sections, diffusion, slowing down, and thermalization of neutrons; homogeneous reactor theory; introduction to heterogeneous reactor theory and reactor kinetics; computer applications in reactor analysis. 1 unit. Prerequisite: Nuclear Engineering 347, Mathematics 343 and 345, or consent of instructor.

456. Reactor Physics, II. Same as Nuclear Engineering 456. Neutron transport theory; current methods of solution of the transport equation; fast and thermal neutron spectra; applications in heterogeneous reactor analysis and other areas of reactor physics; digital computer methods. 1 unit. Prerequisite: Physics 455 or consent of instructor.

462. Statistical Mechanics and Kinetic Theory. Single-particle distribution functions: classical and quantum mechanical systems, Boltzmann equation, virial theorem, equations of state for gases; formal theory: ensembles, identical particles, thermodynamics of simple systems, distribution functions; non-equilibrium problems: conservation laws and hydrodynamics equations, sound waves, transport coefficients; plasmas, normal Fermi fluid, superfluids, systems with internal degrees of freedom. 1 unit. Prerequisite: Physics 360 and elementary quantum mechanics, or consent of instructor.

463. Low Temperature Theory and Quantum Liquids. Normal Fermi liquids: equilibrium properties, transport equation, quasi-particle collisions, degenerate He^3, Landau theory; formal description of experimental measurements in neutral and charged Fermi liquids; superfluid Bose liquid: He II, rotating buckets, macroscopic description of superfluid flow, two-fluid model, first, second, and quasi-particle sound, vortex lines, microscopic theory; superconductivity: BCS theory, electrodynamics and coherence effects, superconductivity in metals, tunnel effect, flux quantization, microscopic theory of superfluid flow, vortices. 1 unit. Prerequisite: Physics 462, 481, or consent of instructor.

465. Plasma Physics. Basic equations of magnetohydrodynamics; orbit theory; stability of plasma configurations; hydromagnetic waves; plasma oscillations; high-frequency instabilities; spontaneous fluctuation theory; Fokker-Planck equation; transport processes; oscillations in a magnetic field; interaction of electromagnetic waves with plasmas. 1 unit. Prerequisite: Physics 362 and 441, or Electrical Engineering 423, or consent of instructor.

467. Atomic Collision Processes. Same as Electrical Engineering 467. Elastic collisions of electrons with neutral atoms; inelastic electron-atom and electron-molecule collisions; collisions between heavy particles; molecule formation; photo-processes and recombination; negative ions; collisions involving the emission of radiation; theory of spectral line-broadening in plasmas; experimental techniques. 1 unit. Prerequisite: Physics 481; consent of instructor.

470. Introduction to Nuclear and Particle Physics. Basic facts of photons, leptons, hadrons, conservation laws, types of interaction, particle production and stability symmetries, nuclear forces, and ground state properties; two-particle systems: electromagnetic interactions, bound states, and resonances; nucleon-nucleon and meson-nucleon interactions; nuclei: properties of low-lying states,

models, resonant reactions, and direct processes; particles and weak interactions: multipion resonances, symmetry schemes, beta decay and other leptonic processes, strange particle decays. 1 unit. Prerequisite: Registration in Physics 482.

471. Nuclear Physics, I. Systematics of stable nuclei and the nuclear potential; properties of odd-A nuclei; spherical single particle shell model; residual interactions; collective states and deformed nuclei; summary of theory and experiment for low-lying states; momentum distribution of nucleons; fission. 1 unit. Prerequisite: Physics 470 and 482, or consent of instructor.

472. Nuclear Physics, II. Resonance reactions: fast and slow neutron cross sections, neutron and gamma widths, strength functions, giant dipole resonance, compound nucleus, and statistical model; direct reactions: optical model, elastic and inelastic scattering, polarization, angular correlations; spectroscopic factors, intermediate structure, isobaric analogs. 1 unit. Prerequisite: Physics 471.

475. Particle Physics, I. Particles: properties and systematics; S-matrix theory; application of symmetry and invariance principles to decays, production processes and polarization; collision processes; mesonic and baryonic resonances; symmetry schemes; particle scattering at very high energies; theory of pion-nucleon scattering, dispersion relations, Mandelstam representation. 1 unit. Prerequisite: Physics 470 and 482, or consent of instructor.

476. Particle Physics, II. Electromagnetic interactions of particles, form factor, predictions of unitary symmetry; beta and muon decay and capture, conserved and partially conserved currents, neutrino interactions, weak interaction form factors; leptonic and non-leptonic decays of strange particles; neutral K-meson decays; current topics. 1 unit. Prerequisite: Physics 475.

480. Quantum Mechanics, I. Introduction to concepts of quantum theory, with applications. Review of classical Lagrangian mechanics; historical review of quantum phenomena, Bohr theory, and the wave nature of matter; Schrödinger wave equation; one-dimensional potential well and barrier penetration problems; three-dimensional problems, angular momentum, hydrogen atom; simple stationary state perturbation theory, perturbation of energy levels, Stark effect, normal Zeeman effect. 1 unit. Prerequisite: Physics 322 and 342; a course in atomic physics.

481. Quantum Mechanics, II. Principally applications to atomic and molecular structure. Electron spin; spin-orbit coupling, anomalous Zeeman effect; semiclassical treatment of emission and absorption of radiation with examples; selection rules, atomic spectra, x-ray spectra; Pauli principle, helium atom, exchange energy; periodic system of elements, Fermi-Thomas atom; diatomic molecules, electronic motion, vibrational and rotational motion, band spectra; simple collision problems, partial wave analysis, Born approximation. 1 unit. Prerequisite: Physics 480 or consent of instructor.

482. Quantum Mechanics, III. Formal structure of quantum theory; quantum theory of angular momentum, vector addition coefficients, simple tensor operators; collision problems, inelastic scattering, formal scattering theory; elementary treatment of quantization of the radiation field and the interaction of light with matter; introduction to Dirac electron theory. 1 unit. Prerequisite: Physics 481 and 422, or consent of instructor.

487. Topics in Advanced Quantum Theory. The following topics are offered alternately, but not every year.

(a) Advanced Quantum Mechanics. Relativisitic quantum mechanics of a single particle; Dirac equation, Lorentz transformation, properties and bilinear covariants, bound state and scattering problems, Möller and Breit interactions elementary radiation theory, relativistic photoeffect, bremsstrahlung, forma

scattering theory, S-matrix, symmetry principles. 1 unit. Prerequisite: Physics 482.

(b) Quantum Field Theory. Field quantization; scalar and pseudoscalar meson field: electromagnetic field, Dirac field, interacting fields, electrodynamics; meson theory; interaction representation; S-matrix; covariant perturbation theory and Feynman diagrams; Compton scattering; Möller scattering; bremsstrahlung; pair annihilation; charge and mass renormalization; Lamb shift; anomalous electron magnetic moment; Heisenberg representation; dispersion relations; recent developments. 1 unit. Prerequisite: Physics 487a.

489. Solid State Physics, I. Introduction to the modern theory of crystalline materials. Topics treated include crystal symmetry, elastic and thermal properties of solids, optical properties, point defects and imperfections in crystals. 1 unit. Prerequisite: Physics 360, 362, 381, 480, or consent of instructor.

490. Solid State Physics, II. Introduction to band theory of solids, free electron model, electrons in periodic potential, cohesion, transport properties of metals and semiconductors, experimental methods for determining band structure. 1 unit. Prerequisite: Physics 481, 489, or consent of instructor.

491. Solid State Physics, III. Elementary excitations in solids; phonons, electrons, plasmons, excitons, spin waves, treated as elementary excitations in interaction with one another and with external fields and particles. 1 unit. Prerequisite: Physics 481.

497. Individual Study. Individual study in a subject not covered in course offerings may be arranged for credit by registration under this number. ½ or 1 unit.

498. Special Topics in Modern Physics. Seminar. Lecture courses in topics of current interest are given under this number. Subjects are announced in the Time Table. ½ or 1 unit.

499. Thesis Research. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. Modern Experimental Physics, I. Techniques and experiments in the physics of atoms, atomic nuclei, molecules, the solid state, and other areas of modern physical research. 1 unit. Prerequisite: Physics 342; registration in Physics 381.

304. Modern Experimental Physics, II. Continuation of Physics 303. 1 unit. Prerequisite: Physics 303.

321. Theoretical Mechanics. Motion of a particle in one, two, and three dimensions with applications; Kepler's laws and planetary motion; scattering of particles; conservation laws; motion of a rigid body in two dimensions; statics of extended systems. Lectures and problems. 1 unit; no graduate credit is given to graduate physics majors. Prerequisite: General physics; registration in Mathematics 341, 345, or 349.

322. Theoretical Mechanics. Continuation of Physics 321. Moving coordinate frames, fictitious forces; special theory of relativity, conservation laws, particle motion and creation; rigid body motion in three dimensions; gravitation and earth motion; generalized coordinates and Lagrange's equations; constraints, small vibrations. 1 unit. Prerequisite: Physics 321.

341. Electricity and Magnetism. The fundamental laws are introduced using the vector notation stressing Maxwell's equations in the integral form. Topics covered with applications and problems include direct current circuits, circuit theorems, electric and magnetic fields, Gauss' Law, capacitance and inductance; energy and forces associated with these fields in free space and in matter. Lectures, problems, and laboratory. This course is fundamental to advanced

courses and should be elected as early as possible by those intending to specialize in physics. ½ or 1 unit; no graduate credit is given to graduate physics majors. Prerequisite: General physics; credit or registration in Mathematics 341, 343, or 345, or consent of instructor.

342. Electricity and Magnetism. Continuation of Physics 341. Effects associated with changing fields and currents, Faraday's Law, displacement current, transient currents, complex variables in circuit analysis, coupled circuits, and circuit theorems; an introduction to the generation and propagation of electromagnetic waves and the wave equations. ½ or 1 unit; no graduate credit is given to graduate physics majors. Prerequisite: Physics 341.

343. Electronic Circuits. The physics of vacuum tube and semiconductor devices; theory and application of these devices as linear circuit elements in power supplies, amplifiers, communication circuits and control circuits. Emphasis is on experimental techniques. Lectures, problems, and laboratory. 1 unit. Prerequisite: Physics 341 or consent of instructor.

344. Electronic Circuits. Continuation of Physics 343. Electronic instruments and techniques used in research in physics and digital computers; theory and experiments emphasizing the use and design of nonlinear circuits, e.g., multivibrators, pulse generators, counters, etc.; theory of switching circuits; special topics. 1 unit. Prerequisite: Physics 343 or equivalent.

347. Electromagnetic Theory and Boundary Value Problems. Beginning with Maxwell's equations, this course treats electrostatic and magnetostatic boundary value problems and multipole expansions with orthogonal polynomials, boundary value problems in quasistatic and radiation fields, simple radiating systems, and scattering of scalar waves. 1 unit. Prerequisite: Mathematics 343 and 345, Physics 342 or Electrical Engineering 229; or consent of instructor.

360. Thermodynamics. Zeroth, first, second, and third laws of thermodynamics; applications to simple physical and chemical systems; thermodynamic inequalities and equilibrium; phase transitions. Lectures and problems. 1 unit. Prerequisite: General physics and calculus; senior standing in physics is advised.

362. Kinetic Theory and Statistics. A lecture and problem course presenting the fundamentals of kinetic theory and an elementary introduction to statistical mechanics. Topics covered include the distribution law, equations of state, viscosity, diffusion, thermal conduction, Maxwell-Boltzmann, Bose, Einstein, and Fermi-Dirac statistics and applications. 1 unit. Prerequisite: Physics 360 or consent of instructor.

366. Aeronomy: Physics of the Upper Atmosphere and Space. Same as Astronomy and Electrical Engineering 366. Structure and composition of the Earth's upper atmosphere; solar radiation and its interaction with the upper atmosphere; the ionospheric layers; planetary atmospheres; airglow and aurora; interplanetary plasma; the magnetic field of the Earth and its interaction with the solar plasma; experimental techniques. 1 unit. Prerequisite: Physics 342, 321 and 381, or consent of instructor.

371. Light. Wave optics: description and superposition of waves, coherence, interference, diffraction, polarization, and dispersion. Geometrical optics: image formation, optical systems, thick lens theory, image defects; applications to optical instruments. Lectures, problems, and laboratory. ½ to 1 unit. Prerequisite: General physics; Mathematics 345 or consent of instructor.

381. Atomic Physics. Same as Chemistry 396. A lecture and problem course presenting our modern knowledge of the nature and properties of electrons, light quanta, atoms, and molecules. Topics discussed include evidence for the atomic nature of matter, the properties of free electrons and ions, photons and their

interaction with matter, atomic spectra and structure, molecular spectra and structure, and an introduction to the ideas of quantum mechanics. A student may not receive credit for both Physics 381 and 386. 1 unit. Prerequisite: General physics and Mathematics 343 or 345; registration in Physics 385 is recommended.

382. **Nuclear Physics.** A lecture and problem course presenting our modern knowledge of the properties of nuclear particles, natural and artificial radioactivity, laboratory equipment for producing and studying high energy particles, nuclear disintegrations, the interaction of nuclear particles with each other and with matter, cosmic rays, mesons, and recent developments in high energy nuclear physics, and the application of nuclear phenomena to some practical problems. 1 unit. Prerequisite: Physics 381 or 383.

383. **Atomic Physics and Quantum Theory for Engineers.** Introduction to the basic concepts of quantum theory which underlie modern theories of the properties of materials. Topics covered include elements of atomic and nuclear theory, kinetic theory and statistical mechanics, quantum theory, and simple applications, atomic spectra and atomic structure, molecular structure and chemical binding. Lectures and problems. ¾ or 1 unit. Prerequisite: General physics; general chemistry; Mathematics 345 or equivalent.

385. **Introduction to Quantum Mechanics.** Experimental foundation; basic postulates; Schrödinger wave equation; hydrogen atom; superposition of states; the calculation of energy, position, momentum and angular momentum; steady state perturbation theory; identical particles, time-dependent perturbation theory; introduction to Dirac theory. The course emphasizes basic principles applied to simple examples, many of them one-dimensional. Numerical methods for the solution of eigenvalue problems are used extensively. Recommended to physics majors and also to students in other physical sciences and engineering. A student may not receive credit for both Physics 385 and 387. 1 unit. Prerequisite: Mathematics 343, Mathematics 345, or consent of instructor; registration in Physics 381 is recommended.

386. **Atomic Physics and Quantum Mechanics, I.** Study of atomic phenomena integrated with an introduction to quantum theory; topics discussed include evidence for the atomic nature of matter and the properties of the Schrödinger equation, single particle solutions in one dimension, the hydrogen atom, perturbation theory, external fields, and atomic spectroscopy of outer electrons. A student may not receive credit for both Physics 381 and 386. 1 unit. Prerequisite: General physics; Mathematics 343 or 345, or consent of instructor.

387. **Atomic Physics and Quantum Mechanics, II.** Continuation of Physics 386. Topics treated include identical particles, spectral hyperfine structure, magnetic properties of matter, atomic spectroscopy of inner electrons, high energy photon effects, molecular, binding and spectra, emission and absorption of light, and symmetry principles. A student may not receive credit for both Physics 385 and 387. 1 unit. Prerequisite: Physics 386.

PHYSIOLOGY AND BIOPHYSICS

See descriptions and course listings under Life Sciences, page 279.

PLANT PATHOLOGY

Graduate work leading to the Master of Science and Doctor of Philosophy is available in the Department of Plant Pathology. Students may choose a major, joint

major, or minor in plant pathology. The following fields are available for specialization: diseases of field crops, forest and shade trees, fruit crops, ornamentals, turf and lawn grasses, and vegetable and canning crops. The student may also specialize in plant virology, nematology, fungicides, antibiotics, physiology of fungi, and biochemistry of plant diseases.

A candidate for the Master of Science must meet the general requirements of the Graduate College, present an acceptable thesis, and pass an oral examination before a committee of staff members. The examination covers courses which the candidate has completed and those in which he is currently registered.

Candidates for the Doctor of Philosophy must meet the general requirements of the Graduate College.

Beginning graduate students are accepted with a grade-point average of 3.75. Applications of students with grade-point averages of 3.5 and below 3.75 are considered on an individual basis.

GRADUATE FACULTY

Professors: W. M. Bever (Head of Department), L. M. Black, J. C. Carter, J. L. Forsberg, J. W. Gerdemann, D. Gottlieb, A. L. Hooker, M. B. Linn, D. Powell, M. C. Shurtleff, H. H. Thornberry.
Associate Professors: M. P. Britton, P. D. Shaw, D. P. Taylor.
Assistant Professors: D. W. Chamberlain, H. Jedlinski, J. D. Paxton.

COURSES FOR GRADUATES

401. Diseases of Forest and Shade Trees. A survey of the history, symptomatology, causes, and control of diseases of trees, with assigned reading and performance of illustrative experiments in the laboratory, greenhouse, and field. Offered in 1970-1971 and in alternate years. ½ or 1 unit. Prerequisite: Plant Pathology 204 or consent of instructor. Carter.

403. Physiology of Fungi. Same as Botany 403. The germination, growth, metabolism, and sporulation of fungi; physiology of the fungi as related to parasitism, antibiotic production, vitamin assay, and industrially important products. The nature of fungicidal activity is discussed. 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Plant Pathology 204 or equivalent; organic chemistry or biochemistry; mycology and microbiology. Gottlieb.

404. Plant Virology. Fundamental concepts; classification, symptomatology; infectivity; biological, chemical, and physical properties; techniques for transmission straining, assay, filtration, and purification; control methods; sources of information; history of virology. ½ or 1 unit. Offered in 1970-1971 and in alternate years. Prerequisite: Consent of instructor. Thornberry.

406. Genetics of Plant-Pathogen Interactions. The genetics and expression of resistance in plants to fungi, bacteria, viruses, nematodes, and other pathogens; variation and genetic systems in pathogens with particular emphasis on pathogenicity; complementary genetic systems; theory and practice of breeding disease resistant plants. Lectures, discussions, assigned reading, and term paper. 1 unit. Offered in 1970-1971 and in alternate years. Prerequisite: Plant Pathology 204 and Botany 210, or Agronomy or Horticulture 323, or consent of instructor. Hooker.

417. Discussions in Plant Pathology. Discussion of current research, literature, and other topics pertaining to plant pathology and related fields. ¼ unit. Staff.

499. Thesis Research. Individual study and research required of all students working toward the Master of Science or Doctor of Philosophy in Plant Pathology. 0 to 4 units. Prerequisite: Plant Pathology 302 or equivalent. Work

can be taken in the following areas, subject to approval of the staff member concerned:

(a) **Biochemistry of Plant Disease.** STAFF.
(b) **Diseases of Corn; Genetics of Resistance.** HOOKER.
(c) **Diseases of Cereal Grains.** BEVER, HOOKER, SHURTLEFF.
(d) **Diseases of Forest and Shade Trees.** CARTER.
(e) **Diseases of Fruit Crops; Fungicides.** POWELL.
(f) **Diseases of Leguminous Crops; Root Diseases.** GERDEMANN.
(g) **Diseases of Turf and Lawn Grasses.** BRITTON.
(h) **Diseases of Soybeans.** CHAMBERLAIN.
(i) **Diseases of Vegetable and Canning Crops.** LINN, SHURTLEFF.
(j) **Nematode Diseases.** TAYLOR.
(k) **Physiology of Fungi; Antibiotics.** GOTTLIEB, SHAW.
(l) **Plant Virology.** BLACK, JEDLINSKI, THORNBERRY.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Special Problems. For students desiring to study specific problems not assigned in other courses. ¼ to 1 unit; maximum accumulated credit, 2 units. STAFF.

302. Research Methods in Plant Pathology. Techniques for the isolation, identification, culture of, and inoculation with plant pathogens; methods for the histological study of diseased plants; recording of data. ¾ unit. Prerequisite: Plant Pathology 204 or equivalent. PAXTON.

303. Plant Nematology. Experimental techniques, nematode anatomy, taxonomy, biology, and host-parasite relations; intensive study of selected groups including foliar, stem, root-knot, and cyst nematodes; interaction with bacteria, fungi, and viruses in plant disease development; control principles. ¾ unit. Offered in 1970-1971 and in alternate years. Prerequisite: Plant Pathology 204 or equivalent; an introductory course in zoology or biology. TAYLOR.

304. Forest Tree Diseases and Wood Deterioration. Symptoms, causal agents, and control of the major forest tree diseases; causes and control of wood deterioration. ¾ unit. GERDEMANN.

305. Principles of Plant Disease Control. A study of the basic concepts of both nonchemical and chemical methods used for the control of plant diseases. Lectures, discussions, and assigned reading. ¾ unit. Offered in 1969-1970 and in alternate years. Prerequisite: Plant Pathology 204; Chemistry 102, 132 or 133; or consent of instructor. POWELL.

306. Epiphytology and Diagnosis of Plant Diseases. Detailed consideration of factors influencing the incidence and severity of diseases caused by fungi, bacteria, viruses, and nematodes; ecological factors as etiological agents, and techniques for determining the intensity of epiphytotics; plant disease identification. ¾ unit. Offered in 1969-1970 and in alternate years. Prerequisite: Plant Pathology 204 or equivalent. BRITTON.

377. Diseases of Field Crops. Same as Agronomy 377. A study of the symptoms of the major field crop diseases, life histories of causal organisms, and methods of control. ¾ unit. Offered in 1969-1970 and in alternate years. Prerequisite: Plant Pathology 204 or equivalent. HOOKER.

POLITICAL SCIENCE

The Department of Political Science offers work leading to the degrees of Master of Arts and Doctor of Philosophy. Graduate work is conducted in the following special fields: American government and politics, comparative government

and politics, international law and relations, political behavior, political theory and jurisprudence.

Admission to graduate work in political science requires a grade-point average of at least 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis. The student must also have had a minimum of twenty hours of undergraduate work in political science, economics, finance, sociology, or history, not less than twelve hours of which must have been in political science (which may include three hours in constitutional history). For additional information, contact the department, 326 Lincoln Hall.

The department also administers a program leading to the Master of Arts in Public Administration. A grade-point average of at least 3.75 and a study proposal leading to a well-defined career or professional objective, approved by the department, are required for admission. The program is offered both in Urbana and through extramural classes in Springfield, and is matched to the individual needs and objectives of students. Programs for students without public service employment usually incorporate an internship of at least three months. Further details may be obtained from the department, 326 Lincoln Hall.

Graduate students in other departments who choose political science as a minor must have at least six hours of undergraduate work in political science and three hours in other social sciences.

The language and research proficiency requirements in political science are: a candidate for the degree of Doctor of Philosophy must demonstrate (1) a reading proficiency in two languages other than English, or (2) a high degree of proficiency in one language other than English, or (3) a reading proficiency in one foreign language and a working knowledge of statistics, mathematics, or computer programming, or (4) high proficiency in statistics, mathematics, or computer programming.

Students may satisfy the requirement for reading proficiency in a language by (1) a direct examination administered by the language department, (2) receiving an acceptable score in the Educational Testing Service Test in the language, or (3) obtaining grades of A or B in French, German, or Russian 401. To satisfy the language requirement by exhibiting a high proficiency in one language, a student must pass a written reading proficiency examination and must (1) show ability to discuss his research and to answer questions in the language, (2) using that language to understand and give a resumé of materials provided by the examiner and (3) carry on a conversation on the subject of his background and plans. The examination is administered by the appropriate language department. Certification of proficiency in foreign languages from other colleges and universities is not acceptable by transfer, but scores on the ETS Language Tests taken elsewhere are accepted and evaluated.

A student may satisfy the requirement of a working knowledge in statistics, mathematics, or computer programming by satisfactory completion of two units in one of those subjects, or the equivalent. The two units may not be used as part of the minor requirement. High proficiency involves the satisfactory completion of four units of work in either statistics, mathematics, or computer programming, or the equivalent; two of these four units may be counted for the minor.

GRADUATE FACULTY

Professors: P. Monypenny (Head of Department), L. J. Barker, R. Dangerfield, M. Davis, G. W. Fisher, S. K. Gove, E. G. Lewis, N. E. Long, E. J. Meehan, S. S. Nagel, J. W. Peltason, R. E. Scott, C. I. Snider, V. A. Thompson.

Associate Professors: Betty Glad, G. Manner, R. L. Merritt, T. Page, G. T. Yu.

Assistant Professors: I. H. Carmen, S. P. Cohen, F. S. Coombs, S. A. Douglas, A. B. Fields, P. Meranto, J. Pisciotte, M. G. Weinbaum.

COURSES FOR GRADUATES

400. Classics of Political Science. Reading, analysis, and discussion of leading works on politics and government. 1 unit. STAFF.

401. History of Political Theories. Reading and analysis of the leading political thinkers from the Greeks to the middle of the seventeenth century. 1 unit.

402. History of Political Theories. Readings and analysis of the leading political thinkers from the middle of the seventeenth century to the present. 1 unit.

406. Municipal Administration. Position of cities in American governmental systems; governmental interrelationships; powers; services; current municipal problems. 1 unit.

410. Problems in Rural Local Government. Research in selected topics. 1 unit. SNIDER.

412. Problems in State Government. Research in selected topics in American state government. 1 unit. SNIDER.

420. Formation of Public Policy. Same as Labor and Industrial Relations 420. An examination of the institutional and dynamic forces that shape the making of policy and its administration in the United States; separation of powers, pressure groups, administrative and legislative procedures, judicial activity. 1 unit.

421. Government and the Economic Order. Seminar in problems of government regulation of economic activity. This course is concerned with research materials, research papers, and related matters. 1 unit.

425. Personality and Political Process. Rationality and its limits in political processes: the functions of symbols and myth in politics; political involvement and quiescence; nonrational elements in legislation and administration. 1 unit. Prerequisite: Consent of instructor.

426. Political Parties. Special problems in political parties; methods and materials of research in this field. 1 unit.

427. Psychological Base of Political Behavior. This course is intended to introduce the student to relations between psychological mechanisms and life history factors and individual or group political behavior. Topics covered include national loyalty and ideology, mass public and political involvement, political authority, and individual compliance. 1 unit.

430. Proseminar in Comparative Politics. Comparative political analysis in the context of the evolution of the social sciences and modern political science, with emphasis on theories of political action and their function in contemporary comparative studies. This course is designed as an introduction to area oriented seminars and generally is a prerequisite for them. 1 unit.

431. Problems of British Government. Special topics relating to British government. 1 unit. LEWIS.

435. Problems in the Government of Soviet Russia. Special topics relating to the government of the Soviet Union. 1 unit.

437. Problems in Chinese Politics and Government. Research in selected topics relating to the political system of China. 1 unit; may be repeated for credit not to exceed 2 units. Prerequisite: Credit or registration in Political Science 430, or consent of instructor.

440. Comparative Politics and the Political Process. The comparative study of selected national political systems or of specific institutional forces that influ-

ence the making and application of public policy in several countries. The countries studied and the legal and extra-legal political agencies considered vary according to the person conducting the seminar. 1 unit; may be repeated for credit not to exceed 3 units. STAFF.

441. Politics in the Developing States. An examination of the political processes in the developing countries. The general problems arising in the transition from traditional societies to modern industrial states are examined to describe the typical patterns of political change. Special attention is given to contemporary literature and studies. 1 unit. Prerequisite: Political Science 430; consent of instructor. SCOTT.

442. Problems of Latin-American Politics and Government. Special topics relating to Latin-American politics and government. Individual countries may be studied or comparative analysis of particular political and governmental functions or problems may be undertaken. 1 unit; may be repeated for credit not to exceed 2 units. Prerequisite: Political Science 430 and 431, or equivalent. SCOTT.

446. Problems of Southeast Asian Politics and Government. Research in the political systems of Southeast Asia. 1 unit; may be repeated for credit not to exceed 2 units. Prerequisite: Credit or registration in Political Science 430, or consent of instructor.

448. Problems in Japanese Politics and Government. Study of scholarly literature on modern Japanese politics and examination of selected problems in modern Japanese politics. 1 unit; may be repeated for credit not to exceed 2 units. Prerequisite: Credit or registration in Political Science 430, or consent of instructor.

449. Problems of South Asian Politics and Government. Research in the political systems of South Asia. 1 unit; may be repeated for credit not to exceed 2 units. Prerequisite: Credit or registration in Political Science 430, or consent of instructor.

450. Contemporary Governmental Problems. Special problems of current importance. Designed especially for students not majoring in political science. 1 unit; may be repeated for credit not to exceed 3 units. STAFF.

451. Constitutional Law. Research in selected topics in the American constitutional system. 1 unit. Prerequisite: Political Science 351 or equivalent. NAGEL.

453. Law, Policy, and Social Science. The application of social science research techniques to improving legal procedure and legal substance. Emphasis is placed on constitutional law and other public law subjects, but other fields of law are also considered. 1 unit.

460. Organizational Sciences, I. Same as Industrial Administration 410, Psychology 453, and Sociology 456. An introduction to the principal theories and important empirical research in various disciplines that study organizations. In addition to examination of the subject matter content of various disciplines students critically examine the capacities and limitations of the various fields to make contributions to the study of organizations. 1 unit. Prerequisite: Enrollment as a major in organizational sciences in a cooperating program or approval of instructor.

461. Organizational Sciences, II. Same as Industrial Administration 411, Psychology 454, and Sociology 457. An introduction to the principal theories and important empiricial research in various disciplines that study organizations. In addition to examination of the subject matter content of various disciplines students critically examine the capacities and limitations of the various fields to make contributions to the study of organizations. 1 unit. Prerequisite: Political Science 460.

465. **Problems in Administrative Management.** An analysis of methods of applying administrative principles and procedures to operating problems in government agencies, such as methods of administrative coordination and control, intergovernmental cooperation, legislative-administrative relations, the organization of regulatory functions, and review of administrative decisions. 1 unit. Prerequisite: Political Science 361 or consent of instructor. MONYPENNY, PAGE.

466. **Current Administrative Theory.** A discussion of some recent trends in administrative opinion and practice on such questions as agency structure and functional activities; field and regional organization and relations; the role and functions of the executive; the process of decision making; the relations of line and staff activities; the communication and execution of policies and programs; and employee relations. 1 unit. MONYPENNY, THOMPSON.

471. **Problems in International Organization.** Methods and materials of research in international organization; special topics, such as disarmament, security, procedural problems in the United Nations, economic and social problems, amendment and revision of the Charter. 1 unit.

481. **Foreign Relations of the United States.** Special problems in the development and conduct of American foreign policy. 1 unit. DANGERFIELD.

484. **International Relations.** An analysis of the approaches and methods used in the study of international relations; the characteristics of states and of international systems; the problem of conflict and its resolution. 1 unit.

485. **International Law.** Research on selected topics. 1 unit. MANNER.

490. **Proseminar in Political Behavior.** Interdisciplinary approaches to the analysis of political behavior; formation of opinions, interests, roles, and personality; applications of organization theory to political institutions; applications of conflict and bargaining theory to political processes; systematic studies of the distribution of values. 1 unit.

491. **Proseminar in Political Behavior.** Interdisciplinary approaches to the analysis of political behavior; formation of opinions, interests, roles, and personality; applications of organization theory to political institutions; applications of conflict and bargaining theory to political processes; systematic studies of the distribution of values. 1 unit. Prerequisite: Political Science 490.

492. **Problems of Explanation in Social Science.** Special topics in the methodology of social sciences, especially theory formation, theory testing. 1 unit.

493. **Research in Selected Topics.** Research in selected topics by arrangement with the instructor. ½ to 3 units. STAFF.

494. **Systematic Social Criticism.** Problems of social criticism in contemporary society; relation of social criticism and social policies. 1 unit. Prerequisite: Political Science 492 or consent of instructor.

495. **Scope and Methods of Political Science.** Definitions of the scope and subject matter of political science; methodological issues in political science; major conceptions of methodology as embodied in current leading studies of politics; the present state of research in political science. 1 unit. MONYPENNY.

496. **Political Concepts: Formulation and Measurement.** The course is designed to indicate the relevance of certain research techniques for answering questions of concern in political science and to indicate the range of tools available to the student. Problems in concept formation are discussed. Current methods of concept measurement are presented to the student in the context of political research problems. 1 unit. Prerequisite: Consent of instructor.

497. **Research Design and Techniques.** This course is intended to introduce the student to problems of research design, data collection, data analysis and

interpretation, sampling, and some simple measures of statistical association and significance. 1 unit. Prerequisite: Political Science 496.

498. The Logic of Political Inquiry: Selected Topics. Application of analytic principles and procedures developed in Political Science 495 to such topics as: patterns of explanation; current theoretical perspectives; group theory, functionalism, systems theory, decision making, simulation, etc.; the logic of judicial decisions; justification of political ideologies. This list is not exhaustive, nor with all of these topics be included each semester. 1 unit; may be repeated for credit not to exceed 2 units. Prerequisite: Political Science 495.

499. Thesis Research. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

305. Municipal Government. Growth of cities; their legal status; municipal politics and organization in the United States. ½ or 1 unit.

306. Municipal Problems. Municipal administration in the United States; administrative organization; personnel problems; financial problems, city planning and housing; police and fire administration; public health; public utilities. ½ or 1 unit. Prerequisite: Political Science 305, or Economics 102 and 103, or six hours of political science.

310. Rural Local Government. Development of local government in rural America; state-local relationships; legal status of local units; organization and functions of counties, townships, school districts, and special-purpose districts; rural politics and elections; local finance; problems of reorganization. ½ or 1 unit. SNIDER.

312. State Government. The states in the federal system; state constitutions and problems of revision; organization, powers, and functions of the legislative, administrative, and judicial branches of state government; state functions; reorganization problems in the states; state-local relations; state finance; trends and prospects. Students are not given credit for both Political Science 110 and 312. ½ or 1 unit. Prerequisite: Political Science 150 or 191. SNIDER.

315. Legislatures and Legislation. The legislative function in government; structure and organization of American legislatures, national, state, and local; party organization in legislatures; legislative procedure, pressure groups and lobbying; relation of legislature to other branches of government; problems of legislative reorganization. ½ or 1 unit. Prerequisite: Six hours of political science.

317. The American Federal System. The nature, justification, and problems of federalism; coordination of governmental efforts by contract, subsidies, and grants; comparison of federal systems. ½ or 1 unit. Prerequisite: Political Science 150 or 191. FISHER.

318. Tax Politics and Administration. Interactions among the administrative, legal and legislative aspects of the fiscal decision-making process at federal, state, and local levels, with emphasis on current issues. ½ or 1 unit. Prerequisite: Political Science 150 or 191. FISHER.

321. Government and the Economic Order. A survey of public policies of national and state governments regulating economic activity; transportation, electrical utilities, communications, anti-monopoly, agriculture, level of economic activity. ½ or 1 unit. Prerequisite: Two courses in political science or in political science and economics.

326. American Political Parties. Organization and operation of the American party system; relations between national, state, and local organizations; state and

national committees; the convention system; the primary; campaign methods and finance. ½ or 1 unit. Prerequisite: Political Science 150 or 191, or consent of instructor. WEINBAUM.

328. **Introduction to the Study of Political Behavior.** An analysis of the interrelations of political attitudes and public policy formation. Special attention is given to the substantive areas of voting behavior, political leadership, and the rise of political mass movements. The course also includes a review of the literature on democratic and authoritarian personality types. ½ or 1 unit. Prerequisite: Political Science 150 or equivalent.

329. **Electoral Behavior.** A study of the social and psychological motivations behind the individual voting decision, with special emphasis on the relationships between the voting decision and social stability. ½ or 1 unit. Prerequisite: Six hours of political science. MILLER.

331. **British Government.** Nature of the British constitution; the crown, ministry, and cabinet; Parliament and elections; the party system; law and the courts; local government; the British Commonwealth. ½ or 1 unit. DAVIS, LEWIS, STESLICKE.

335. **Government and Politics of the Soviet Union.** Evolution, structure, and functioning of the Soviet system of government; the theories, structure, and functioning of the Communist party of the Soviet Union. ½ or 1 unit.

336. **Governments and Politics in Western Continental Europe.** An analysis of the major governmental systems of Continental Europe; the evolution, structure, and functioning of the political institutions of France, Germany, Italy, Spain, Switzerland, and the Scandinavian countries as illustrations of multiparty and dictatorial types of governments. ½ or 1 unit. LEWIS.

337. **Government and Politics of China.** An introduction to the governments and politics of modern China. ½ or 1 unit. Prerequisite: Six hours of political science.

338. **Governments and Politics in the Middle East.** An analysis of the transformation of Middle Eastern society from Morocco to Iran as case studies in political modernization. The politics of the area is studied with special reference to causes and character of modernization, role of leadership, ideologies, and institutions; methods and theories for analyzing political systems undergoing fundamental transformation, and implications for United States policy. ½ or 1 unit. Prerequisite: Six hours of political science.

339. **Governments and Politics in Sub-Saharan Africa.** Analysis of major political systems in Africa south of the Sahara. Emphasis on the development of states and the modification of social and political systems. A general survey of the area is supplemented by a focus on selected countries. ½ to 1 unit. Prerequisite: Six hours of political science.

340. **The German Political System.** Structures and processes of postwar German politics, with primary emphasis on West Germany; special attention is paid to foreign policy formulation and problems, particularly defense, the Berlin issue, reunification, and relations with Eastern Europe. ½ or 1 unit. Prerequisite: Knowledge of German helpful, but not necessary.

342. **Government and Politics in Latin America.** A survey of the origin and development of Latin-American political institutions; systems of government; public administrative systems; party government; international policies of Latin-American governments. ½ or 1 unit. Prerequisite: Six hours of political science. SCOTT.

343. Political Systems and Structures of Latin-American Countries. The political process, generally of selected Latin-American countries at different levels of political development, with stress on the interaction between political infrastructure and more formal agencies of government. May include cross-national comparison of the function of such factors as political culture, party system, bureaucracy, or the military establishment. ½ or 1 unit. Prerequisite: Political Science 342. SCOTT.

345. Theory and Practice of Democratic Government. Theories of the nature and conditions of democracy; contemporary democratic institutions compared and analyzed. ½ or 1 unit. Prerequisite: Political Science 150 or 191.

346. Theory and Practice of Communism. A survey of the international Communist movement; the origins of modern communism and the nineteenth-century development of its doctrines; the Russian Revolution; Lenin and Stalin, the U.S.S.R. as a model for communism; the regional development of Communist parties. ½ or 1 unit.

347. Governments and Politics of Southeast Asia. A comparative analysis of the political development of the countries of Southeast Asia, the lands to the east of India and south of China, emphasizing the differing approaches to the governing of man and the formation of public policy to be found in these countries. Economic, social, historical, and geographical influences on political development are considered. ½ or 1 unit. Prerequisite: Six hours of political science or consent of instructor.

348. Government and Politics of Japan. An introduction to the government and politics of modern Japan. ½ or 1 unit. Prerequisite: Six hours of political science.

349. Governments and Politics of South Asia. A comparative analysis of the political development of India, Pakistan, Ceylon, and the lesser lands of South Asia, emphasizing the differing approaches to the governing of man and the formation of public policy to be found in these countries. Economic, social, historical, and geographical influences on political development are considered. ½ or 1 unit. Prerequisite: Six hours of political science or consent of instructor.

350. Introduction to Law. An introductory study of the nature of law, the functions of private law, the functions of public law, social change and law, and the limits of effective legal action. ½ or 1 unit. NAGEL.

351. American Constitutional System. Judicial interpretation of the Constitution; separation of governmental powers; relation of state and national governments; control of interstate commerce; jurisdiction of courts. ½ or 1 unit. Prerequisite: Political Science 150 or 191. NAGEL.

352. Comparative Constitutional Law. A comparative analysis of the constitutional law cases from a variety of countries with particular emphasis on how the cases have resolved issues relating to civil liberties and the allocation of power among governmental bodies. ½ or 1 unit. Prerequisite: Political Science 150 or 191. NAGEL.

353. Law and Politics of Poverty. The study of court cases and other materials dealing with the legal rights and obligations of the poor as tenants, consumers, welfare recipients, employees, arrested persons, family members, legal clients, and political participants. The materials emphasize the constitutional, political, and sociological aspects of the legal rights involved including the political process through which relevant judicial and legislative policy is made and applied. ½ or 1 unit. Prerequisite: Political Science 150 or 191.

354. The Judicial Process. A systematic analysis of legal, evidentiary, environmental, and personal factors that influence judicial decision making, with particular

emphasis on the application of the scientific method to the study of judicial behavior. ½ or 1 unit. Prerequisite: Political Science 150 or 191. NAGEL.

355. The Constitution and Civil Liberties. A study of free speech, loyalty in a democratic state, citizenship, freedom of religion, rights of persons accused of crime, and government's responsibility to protect persons from racial and religious discrimination, with special attention to the role of law and judges. ½ or 1 unit. Prerequisite: Political Science 150 or 191. NAGEL.

356. Public Administration and the Judicial Process. The scope of administrative powers and their relation to private rights. A comparison of the processes of decision in administrative agencies and in the courts; the interests served by each; the impact of judicial review of administrative decisions upon administrative procedure and policy; the constitutional and statutory bases of review; the legal accountability of public officers versus political accountability. ½ or 1 unit. Prerequisite: Political Science 305 or 351, or consent of instructor. NAGEL.

357. The Process of Law Enforcement. Problems in the procedure of law enforcement including the nature and ramification of crime; the nature and sources of law; character and types of criminal law; structure of the court system and its role in criminal enforcement; agencies of law enforcement—federal, state, and local; interstate crime control; the police and crime detection; prosecution of criminal offenses; problems of judicial procedure; and correctional procedures. ½ unit. Prerequisite: Political Science 150 or 151.

359. Jurisprudence. Nature and sources of law; law and the state; law and justice; evolution, arrangement, and subject matter of law. ½ or 1 unit. Prerequisite: Political Science 150 or 191. MANNER.

361. Introduction to Public Administration. Development of administrative organizations; administration and the executive, legislative, and judiciary; principles of organization, including line and staff relationships; the staff services of finance and personnel; formal and informal control. ½ or 1 unit. Prerequisite: Political Science 150 or 191. MONYPENNY, PAGE.

362. Administrative Organization and Policy Development. Dynamics of policy formulation in public administrative agencies; current developments in organizational theory and their significance for public administration; origin of public administrative organizations; interpersonal behavior; large-scale organizations and centralization; external support and opposition; policy formation and problems of compliance. ½ or 1 unit. Prerequisite: Six hours of political science or consent of instructor.

365. Government and Labor. Same as Labor and Industrial Relations 365. Critical analysis of the relationship between group pressures on government and public policy affecting labor; role of administration in formation of policy; problems and experience of federal agencies operating in the labor fields. ½ or 1 unit. Prerequisite: Political Science 150 or 191.

366. Tools of Public Management. A critical survey of the tools of analysis available to overhead functions of public management in key areas of decision; emphasis on personnel administration and manpower utilization, budgetary processes and fiscal controls, and several methods of administrative analysis—organizational studies, procedures engineering, information processing, and operations research. 1 unit. Prerequisite: Political Science 361 or consent of instructor. MONYPENNY, PAGE.

371. World International Organization. General development and basic principles of world organization; principles, structure, methods, and actual operation of international governmental institutions; special attention to the United Nations and related agencies and to their evolution from the League of Nations system. ½ or 1 unit.

372. Regional International Organizations. Descriptive and comparative analysis of various regional international organizations, their role in contemporary politics and their relationship to the United Nations system; structure, functions, and accomplishments of North Atlantic Treaty Organization, Southeast Asia Treaty Organization, Organization of American States, and other regional international organizations. ½ or 1 unit. STESLICKE.

380. Comparative Foreign Policies. An analysis of the formulation and substance of the foreign policies of select nations of the world. ½ or 1 unit. Prerequisite: Political Science 184 or consent of instructor.

381. American Foreign Relations. Participation in international affairs; presidential initiative; development and organization of the Department of State; diplomatic intercourse; consular service; treaty-making power; development of foreign policy. ½ or 1 unit. Prerequisite: Six hours of political science. GLAD.

382. Contemporary American Foreign Policies. Study of the major foreign policy decisions currently confronting the United States government: analysis of background, principal issues, alternative actions, formulation of policies. ½ or 1 unit. Prerequisite: Political Science 381 or consent of instructor. DANGERFIELD, GLAD.

383. Soviet Foreign Policy. A survey of Soviet foreign policy from 1917 to the present, with emphasis upon the forces shaping this policy. Special attention is given to the interplay of ideology and national interest in policy formulation. ½ or 1 unit.

384. International Relations. An examination of contemporary international systems in terms of the types of actors and their goals, various structures of power, and the mechanisms of allocating resources and containing conflict. ½ or 1 unit. Prerequisite: Junior standing.

385. International Law. Nature, sources, and development of international law and certain basic rights and obligations of the subjects thereof. ½ or 1 unit. MANNER.

386. International Law. Responsibility, intercourse, and redress of differences between states. ½ or 1 unit. MANNER.

387. National Security Policy. An examination of the organization and formulation of current American defense policy; the theory of deterrence, with special reference to American and Soviet military strategy; the problems of disarmament and arms control. ½ or 1 unit. Prerequisite: Political Science 184 or consent of instructor.

388. The Military and Politics. The role of the military in national and international politics, with special attention given to theories of war and peace, civil-military relations, the military and the political development of Western and non-Western states, and the non-military uses of the military. ½ or 1 unit. Prequisite: Political Science 184 or 192, or consent of instructor.

389. Chinese Foreign Policy. An analysis of the formulation, substance, and conduct of Chinese foreign policy, with emphasis on the period since 1949. Special attention is given to the forces shaping Chinese policy. ½ or 1 unit. Prerequisite: Six hours of political science or consent of instructor.

390. Methods of Political Analysis. Presentation of the analytic processes in the development of concepts, hypotheses, and theories. Discussion of the derivation, formulation, and specification of research problems to be related to basic methodologies and modes of analysis. Applications to political science. ½ or 1 unit. Prerequisite: Political Science 150 or 191, or consent of instructor.

393. History of Political Theory. A survey of the major trends and issues in European political thought. Greek and Roman theories of politics; the development of Christian political thought and the Middle Ages; political theory during the Renaissance, Reformation, and the Counter-Reformation; early modern absolutism, the emergence of constitutional government, and the theory of democracy; the Enlightenment; European liberalism, conservatism, utopianism, and socialism. ½ or 1 unit.

396. Contemporary Political Theory. Major tendencies in Western political theory since 1850; conservatism and constitutionalism; the religious interpretation of the state and economic institutions; Marxism, socialism, and communism; antidemocratic thought and totalitarian regimes. ½ or 1 unit.

397. American Political Theory. A survey of American political thought from colonial times to the present. ½ or 1 unit. Offered in 1969-1970 and in alternate years.

PSYCHOLOGY

The Department of Psychology offers graduate work leading to the degrees of Master of Arts, Master of Science, Doctor of Philosophy, and Doctor of Psychology.

Fields. Doctor of Philosophy programs are offered in the following special areas of psychology: child development, clinical and counseling psychology, higher processes, industrial psychology, learning, personality, physiological psychology, psycholinguistics, psychological measurement, school psychology, sensation-perception, and social psychology. The Master of Arts degree is awarded to students in the above programs as an intermediate degree.

Master of Science programs are offered in personnel psychology, applied experimental psychology, measurement psychology, school psychology, and clinical and counseling psychology.

The Doctor of Psychology program is restricted to clinical and counseling psychology.

Admission. The candidate for the Master of Arts or Doctor of Philosophy must meet the following departmental requirements: (1) a minimum of fifteen hours in psychology; (2) a laboratory course in experimental psychology and a course in statistics; (3) a one-year course in another laboratory science; (4) a grade-point average of 4.0, though this may be waived for a student from a highly selective institution; (5) high scores on the Graduate Record Examination. Preference is given to students who have some research experience and who have taken mathematics beyond college algebra.

The candidate for the Master of Science program must ordinarily have completed an undergraduate major in applied psychology at the University of Illinois. Students with an average of 3.5 may apply.

The candidate for the Doctor of Psychology must meet the following departmental requirements: (1) a minimum of twenty hours in psychology; (2) a course in statistics and a course in tests and measurements; (3) a minimum of twenty hours selected from anthropology, economics, education, political science, social work, and sociology; (4) a grade-point average of 4.0, though this may be waived for a student from a highly selective institution; (5) high scores on the Graduate Record Examination.

Because it is necessary to limit admissions to graduate study in psychology, it is not possible to accept all applicants who meet the minimal requirements for any of the above programs.

Minor. The prerequisite for a graduate minor in psychology is nine semester hours in undergraduate psychology and a course in statistics.

Requirements for Degrees. The Master of Arts is awarded to candidates who

complete satisfactorily eight units of work, including an acceptable thesis. The Doctor of Philosophy is awarded to candidates who go on to complete an approved program in their area of specialization and meet Graduate College requirements for the degree.

The Master of Science is awarded to candidates who complete satisfactorily eight units of work after completing an applied psychology undergraduate major at the University of Illinois.

The Doctor of Psychology is awarded in clinical and counseling psychology when the following requirements have been completed: (1) three years of full-time course work consisting of twenty-four to twenty-eight units, of which twenty units must be at the 400 level; (2) one summer session of orientation in a hospital or clinic plus one summer session of practicum in a hospital or clinic; (3) a preliminary examination administered by a committee appointed by the Dean of the Graduate College; (4) one year of internship following the third year of course work; (5) a report on the year of internship (not a dissertation); (6) a final examination administered by a committee appointed by the Dean of the Graduate College.

TRAINEESHIPS

United States Public Health Service Traineeships in Child, Measurement, and Clinical Psychology. Graduate students, including first-year applicants, are automatically considered for these appointments. No application is necessary. Current stipends vary as a function of the level of the appointment and the length of the appointment. Tuition and fees are paid; a limited number of dependency allowances are available. The trainee has no duties other than full-time graduate work.

Veterans Administration Traineeships in Clinical and in Counseling Psychology. First-year students are not eligible for these appointments. Applicants for advanced standing may apply for a traineeship by a letter addressed to the head of the Department of Psychology. The trainee works approximately half-time in a Veterans Administration hospital as a Civil Service appointee.

Illinois Department of Mental Health Traineeships in Clinical Psychology. Traineeships similar to those from the United States Public Health Service plus exemption from tuition and fees are available to students with special interests in professional clinical work.

GRADUATE FACULTY

Professors: L. G. Humphreys (Head of Department), J. A. Adams, H. W. Ades, R. C. Anderson, W. R. Ashby, W. C. Becker, S. W. Bijou, R. B. Cattell, F. Costin, D. E. Dulany, C. W. Eriksen, T. N. Ewing, F. E. Fiedler, W. M. Gilbert, G. R. Grice, H. W. Hake, R. Hamlin, J. Hirsch, J. McV. Hunt, W. E. Kappauf, L. H. Lanier, J. E. McGrath, C. S. Moss, O. H. Mowrer, C. E. Osgood, D. R. Peterson, I. D. Steiner, M. M. Tatsuoka, H. C. Triandis, L. R. Tucker, L. P. Ullmann, M. W. Weir, J. S. Wiggins.

Associate Professors: R. S. Bogartz, J. B. Cohen, J. H. Davis, M. E. Fishbein, C. L. Hulin, L. A. Jakobovits, Alice K. Jonietz, W. E. Montague, G. L. Paul, K. E. Renner, D. T. Shannon, R. L. Sprague, M. Wagman, J. S. Werry.

Assistant Professors: L. C. Ate, W. H. Batchelder, D. Bernstein, G. L. Clore, Jr., L. B. Cohen, N. H. Eisen, F. Fehr, Angela Folsom, G. B. Graen, G. Z. Greenberg, K. T. Hill, R. Malpass, W. R. Mead, R. J. Menges, S. M. Nealey, R. Peterson, J. Rappaport, L. G. Richards, R. J. Rose, E. A. Schenck, K. G. Scott, T. Steiner, Nancy Wiggins, R. G. Williges.

COURSES FOR GRADUATES

The prerequisites stated apply to graduate majors in psychology. Students minoring in psychology may, by special permission of instructors, enroll in certain of these courses without having met all the prerequisites.

402. **Systematic Psychology.** A critical analysis and comparison of modern and contemporary psychological systems. 1 unit. Prerequisite: Twelve hours of psychology. DULANY.

403. **Proseminar in General Psychology, I.** A brief historical introduction to modern psychology; fundamentals of differential psychology, including the measurement of intelligence, aptitudes, and personality; motivation, emotion, and mechanisms of defense; psychological development; social behavior. 1 unit. Prerequisite: Twelve hours of psychology. STAFF.

404. **Proseminar in General Psychology, II.** Sensory processes; perception; fundamental processes in learning; learning theory; special aspects of human learning; language behavior; thinking; logical aspects of psychological theory. 1 unit. Prerequisite: Twelve hours of psychology. STAFF.

408. **Design of Experiments in Psychology.** Advanced experimental designs in psychological research; special methods of data analysis. 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Psychology 307. KAPPAUF.

409. **Psychological Scaling.** Same as Sociology 409. Scaling theory and methodology, with emphasis upon measurement in psychophysics, differential psychology, and social psychology. 1 unit. Offered in 1970-1971 and in alternate years. Prerequisite: Psychology 307. BATCHELDER, TATSUOKA, TUCKER.

411. **Advanced Physiological Psychology.** Detailed examination of the physiological mechanisms in behavior. Research methodology and contemporary literature in the physiology of motivation; learning, perception, and emotion are emphasized. Laboratory demonstrations and problems. 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 311 or equivalent. MEAD.

413. **Computer Applications in Social Statistical Research.** Same as Computer Science and Sociology 413. Computer procedures for the analysis of sociological and psychological data, including probability matrices, dominance matrices, clique analysis, regression analysis, analysis of variance and covariance, canonical correlations, discriminant analysis, and factor analysis. 1 unit. Prerequisite: Sociology 387 or equivalent in statistics; may be taken concurrently with Sociology 387. DICKMAN.

414. **Experimental Personality Research.** A laboratory training course emphasizing physiological, perceptual, learning, and genetic approaches to the experimental study of personality. Critical surveys of recent research literature are combined with laboratory training in representative techniques. 1 unit. Prerequisite: Psychology 307 and 404; consent of instructor.

415. **Experimental Sensory Psychology.** A systematic study of sensory processes, including vision, audition, gustation, olfaction, and somesthesis. Experimental methods, research findings, and theory are emphasized. 1 unit. Prerequisite: Twelve hours of psychology, including a laboratory course in experimental psychology. GREENBERG, KAPPAUF.

416. **Perception.** Systematic study of methods and research findings in the field of human perception, together with an evaluation of theoretical interpretations. 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Twelve hours of psychology. HAKE.

417. Experimental Psychology of Learning, I: Basic Processes. A study of experimental investigation of basic learning processes, with emphasis upon the nature of the problems, experimental procedures, and theoretical significance. 1 unit. Prerequisite: Twelve hours of psychology.

418. Experimental Psychology of Learning, II: Human Learning. Investigation and theory related to perceptual, motor, and verbal learning; retention and forgetting; transfer of training; mediational processes; reasoning. 1 unit. Prerequisite: Psychology 417 or consent of instructor. ADAMS.

419. Advanced Comparative Psychology. A critical survey of techniques, results, and problems in the study of animal behavior and human behavior from the comparative-evolutionary point of view. Laboratory demonstrations and individual research problems. 1 unit. Prerequisite: Twelve hours of psychology or biology. HIRSCH.

421. Problems in Motivation. 1 unit. Prerequisite: Twelve hours of psychology.

425. Psycholinguistics. Same as Communications and Linguistics 425. A critical survey of methods and theories in the psychological study of the communication process, with emphasis upon linguistic, information-theory and learning theory approaches, psycholinguistic analysis of language decoding and encoding, and the development and measurement of symbolic processes, including meaning. 1 unit. Prerequisite: Consent of instructor. OSGOOD.

426. Research Seminar in Psycholinguistics. Same as Communications and Linguistics 426. Critical discussion of research problems to which psycholinguistic theories and techniques can be applied. Students taking this course plan, execute, and report an original piece of research in this area. ½ or 1 unit. Prerequisite: Psychology 425; consent of instructor. OSGOOD.

427. Engineering Psychology. Experimental psychology applied to the study of man-machine interrelationships; psychological factors in the design of communication and control equipment. 1 unit. Prerequisite: A laboratory course in experimental psychology or equivalent. HAKE.

428. Higher Process. An examination of method, theory, and research in the study of thinking; status of cognition as a construct; verbal control of behavior; concepts, problem solving, attention, language and thought; cognitive processes as a source of motivation. 1 unit. Prerequisite: Twelve hours of psychology including a laboratory course in experimental psychology. DULANY.

429. Second Language Acquisition and Bilingualism. An examination of the field from a psycholinguistic perspective. The following topics are discussed: first vs. second language acquisition, the nature of language aptitude and competence, methods of second language teaching, the nature of bilingualism, and comparative psycholinguistics. 1 unit. Prerequisite: Consent of instructor. JAKOBOVITS.

431. Psychological Measurement in Industry. Application of psychometric methods and the findings of differential psychology to the selection, classification, and performance evaluation of industrial personnel. 1 unit. Prerequisite: Psychology 307 or equivalent. HULIN.

435. Motivation and Morale in Industry. Same as Labor and Industrial Relations 435. Concepts and methods in the study of motivation of employees; determinants of employee attitudes and job satisfaction; modification of attitudes and morale. 1 unit. Prerequisite: Four units of graduate credit in psychology or consent of instructor. NEALEY, TRIANDIS.

436. Mathematical Models in Psychology. The course deals with recent developments in mathematical models in psychology. Special emphasis is given human learning, higher processes, and modern psychophysics. ½ or 1 un

Prerequisite: One year of calculus; Psychology 306, 307; or consent of instructor.

438. **Introduction to Clinical Psychology, I.** Introduction to clinical psychology as science and profession. Lectures, discussions, demonstrations, and field observations are provided for overview of clinical psychology. 1 unit. Prerequisite: Graduate standing in clinical psychology; consent of instructor.

439. **Introduction to Clinical Psychology, II.** Continuation of introductory sequence in clinical psychology. Logical issues in assessment, disposition and behavior change are discussed. Preliminary training in interview and observational methods are initiated. 1 unit. Prerequisite: Psychology 438.

441. **Personality and Behavior Dynamics.** The cross-sectional structure of personality, the basic principles of behavior dynamics and the determinants which shape personality development are described. Special topics include typologies, trait measurement, conflict and anxiety, and mechanisms of defense. ½ unit; graduate credit is not allowed for both Psychology 350 and 441. Prerequisite: Twelve hours of psychology. CLORE, WIGGINS.

442. **Behavior Disorders.** A review of the experimental-clinical literature concerning the behavior disorders, with special reference to their classification and etiology. ½ unit. Prerequisite: Psychology 338; consent of instructor. PAUL.

443. **Psychodiagnostics, I.** Instruction and practice in the administration and interpretation of individual tests of general intelligence, special abilities, and achievement. 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 390 or equivalent; Psychology 439. SHANNON.

444. **Psychodiagnostics, II.** Instruction and practice in the administration and interpretation of tests and other instruments used in the assessment of personality, with special emphasis upon projective techniques. 1 unit. Prerequisite: Psychology 443; consent of instructor. SHANNON, WIGGINS.

445. **Behavior Modification.** A critical survey of issues, principles, practice, and research related to modifying human behavior. The course covers psychotherapeutic and somatic approaches; symptomatic relief and personality-restructuring goal-orientations; individual, family, group, milieu, and preventive community intervention. ½ unit. Prerequisite: Psychology 444. Registration in Psychology 447 is strongly recommended. ULLMANN.

446. **Laboratory in Behavior Modification.** Practice in techniques of behavior modification with a focus on recent innovations. Research implications of the newer methods are examined. Small sections of the course are formed according to the specialized interests of students and staff. ½ unit. Prerequisite: Psychology 445.

447. **Practicum.** Supervised practice in the assessment and modification of problem behavior. ½ unit. A student may reregister for a maximum of one unit. Prerequisite: Credit or registration in Psychology 445 and 446. SHANNON.

448. **Practicum in the Study of Individuals.** Substantive material on the study of lives, including: consistency and change in personality over time, relationship of mood and personality structure to behavior, techniques for the longitudinal study of individuals, and an evaluation of the case study method. Each student plans and conducts an experiment testing the application of concepts of personality and behavior dynamics to the study of an individual. Intended for students desiring supervised practicum experience in the assessment of normal behavior. ½ or 1 unit. Prerequisite: Psychology 441. RENNER.

449. **Medicine in Clinical Psychology.** Introduction to areas of medicine and the organization of medical services as appropriate to the practice of clinical psychology. Medical facts, procedures, and viewpoints are presented to enhance

the mutual contributions and collaborative efforts of medicine and clinical psychology. ½ unit. Prerequisite: Second-year graduate standing in clinical psychology or consent of instructor.

450. **Community Psychology.** An introduction to community mental health as an aspect of community psychology. Primary emphases are on the prevention of mental illness, promotion of positive mental health, and provision of continuity of care for the mentally ill in the community itself. ½ unit. Prerequisite: Second-year graduate standing in clinical psychology or consent of instructor.

453. **Organizational Sciences, I.** Same as Industrial Administration 410, Political Science 460, and Sociology 456. An introduction to the principal theories and important empirical research in various disciplines that study organizations. In addition to examination of the subject matter content of various disciplines, students critically examine the capacities and limitations of the various fields to make contributions to the study of organizations. 1 unit. Prerequisite: Enrollment as a major in organizational sciences in a cooperating program or approval of instructor.

454. **Organizational Sciences, II.** Same as Industrial Administration 411, Political Science 461, and Sociology 457. An introduction to the principal theories and important empirical research in various disciplines that study organizations. In addition to examination of the subject matter content of various disciplines, students critically examine the capacities and limitations of the various fields to make contributions to the study of organizations. 1 unit. Prerequisite: Psychology 453.

455. **Research Methods in Organizational Psychology.** Discussion and analysis of strategies, methods, and techniques of organizational psychological research. Emphasis is given to methods for researching behavioral determinants within interdependent organizational roles. 1 unit. Prerequisite: Psychology 351 or 355 or 359, or consent of instructor.

456. **Psychology of Social Communication.** Same as Communications 456. Recent developments in method and theory of attitude change through communication; the nature and determinants of informal social communication; the effects of persuasive communications on public opinion; change in intergroup attitudes through communication. 1 unit. Prerequisite: Psychology 351 or equivalent, or consent of instructor. FISHBEIN.

457. **Theory and Research in Organizational Psychology.** Theory and research on the psychological processes involving the demands of organizations on the behavior of individuals. Emphasis is given to the processes of power, authority, influence, leadership, communications, decision making, and organizational change. 1 unit. Prerequisite: Psychology 455 or consent of instructor.

458. **Group Dynamics.** A critical review of theory, research, and practice related to group behavior, including factors influencing communication, decision making, group cohesiveness, and productivity. 1 unit. Offered in 1970-1971 and in alternate years. Prerequisite: Six units of graduate credit in psychology including Psychology 351 or equivalent. I. STEINER.

459. **Leadership and Group Effectiveness.** Theories of leadership, methodology in research on leadership; leadership and morale; group structure and group productivity; selection and training of leaders; assembling effective groups. 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Psychology 351 or equivalent. FIEDLER.

460. **Motivation and Personality Development in Children.** Theory, method, and research on the interaction of motivational personality, and learning processes and development in children, with emphasis on experimental studies and social learning theory approach. Class projects involve some laboratory work

with children. 1 unit. Prerequisite: Twelve hours of psychology; consent of instructor. HILL.

462. **Human Abilities.** Analysis of individual differences in human abilities, including historical background, measurement methodology, and functional correlates of abilities. The use of ability measures in both experimental and applied research is considered. 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Psychology 307 or equivalent. HUMPHREYS.

463. **Research Methods in Clinical Psychology and Personality.** The logical analysis of clinical inferences and their role in research; problems and methods in the investigation of the development, dynamics, and structure of personality; research in psychotherapy. ½ unit. Prerequisite: Psychology 306 and 403. ERIKSEN, J. S. WIGGINS.

464. **Social Perception.** A review of method and theory in social perception, interpersonal attitudes, cultural influences on social perception, and theoretical analyses from the point of view of consistency theories, exchange, and status congruence theory. 1 unit. Prerequisite: Psychology 351 or equivalent.

465. **Learning in Children.** An examination of laboratory investigations of children's learning, with emphasis on developmental changes as related to current theories of learning and development. Class projects involve some laboratory work with children. 1 unit. Prerequisite: Twelve hours of psychology; consent of instructor. WEIR.

467. **Personality Assessment.** Methods and theory in the quantitative assessment of personality; review of research findings and trends. 1 unit. Offered in 1970-1971 and in alternate years. Prerequisite: Psychology 307 or equivalent. WIGGINS.

468. **Contemporary Behavior Theory.** An introduction to modern attempts to formulate scientific theories of behavior, with special emphasis on theories concerning the learning process, including the work of Hull, Tolman, and Guthrie. 1 unit. Prerequisite: Six units of graduate credit in psychology; consent of instructor.

469. **Cognitive Development.** An examination of laboratory investigations of cognitive development in children, with emphasis on current theories of cognition and language. Class projects involve some laboratory work with children. 1 unit. Prerequisite: Twelve hours of psychology; consent of instructor. L. COHEN.

470. **Principles and Methods of Teaching Psychology.** Designed for graduate students in psychology. Among the major areas considered are: developing course objectives and content; developing and presenting teaching-learning situations; evaluating the attainment of course objectives; advising and counseling students; ethics in teaching; research problems on the teaching of psychology. ½ or 1 unit. Prerequisite: Second-year graduate standing in psychology or consent of instructor. COSTIN.

483. **Psychology of Speech and Hearing Disorders, I.** Same as Speech 483. A survey of psychological techniques utilized in the clinical and experimental study of speech and hearing disorders, with special reference to speech disorders. Review of research findings and development of experimental designs. 1 unit. Prerequisite: Consent of instructor. O'NEILL.

484. **Psychology of Speech and Hearing Disorders, II.** Same as Speech 484. A survey of psychological techniques utilized in the clinical and experimental study of speech and hearing disorders, with special reference to hearing disorders. Review of research findings and development of experimental designs. 1 unit. Prerequisite: Consent of instructor. O'NEILL.

485. **The Sampling of Human Populations and Social Organizations.** Same as Sociology 485. This course covers procedures for selecting samples from and

estimating population parameters for human populations and social organizations. The types of sample designs treated include simple random samples—stratified and cluster samples together with random number and systematic selection techniques. Emphasis is given to the study of various kinds of advanced sample designs for both area and institutional settings together with the problems involved in the application of analytical statistics to complicated sampling procedures. Each student is required to participate in a field project which involves the actual selection of a cluster sample from the local area. 1 unit. Prerequisite: Sociology 387 or Economics 371, or consent of instructor.

490. Individual Research. For graduate students who wish to conduct research on special problems not included in graduate theses. ½ to 2 units. Prerequisite: Consent of instructor. STAFF.

492. Psychology of Learning and Instruction. Same as Educational Psychology 492. An advanced course in the nature and conditions of long-term cognitive learning and retention in classroom and similar situations. This course is intended for doctoral students with a special interest in research leading to the improvement of classroom teaching and learning, in psychological aspects of curriculum research, and in the cognitive aspects of military and industrial training. 1 unit. Prerequisite: Consent of instructor. ANDERSON.

493. Seminar. Discussion of current topics in their historical setting, with special emphasis on research problems. ½ or 1 unit. Prerequisite: Six units of graduate credit in psychology; consent of instructor. STAFF.

494. Multivariate Analysis in Psychology and Education. Same as Educational Psychology and Sociology 494. The principal methods of descriptive statistics used in the analysis of multiple measurements, with emphasis on conventional procedures of factor analysis; profile similarity models; discriminatory analysis; multidimensional scaling. 1 unit. Prerequisite: Psychology 307 or Educational Psychology 496; consent of instructor. TATSUOKA, TUCKER.

495. Theory of Measurement. Same as Educational Psychology 495. Logical and mathematical principles underlying test design, construction, and validation, with particular emphasis on evaluating reliability of measurement, utility resulting from test-based decisions, and validity of descriptions of individuals. 1 unit. Prerequisite: Educational Psychology 496 or Psychology 307, or equivalent; Educational Psychology 392 or Psychology 390, or equivalent. HASTINGS, TUCKER.

499. Thesis Research. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

306. Quantitative Methods, I. A lecture and laboratory course in the development and application of quantitative methods in psychological research. 1 unit Prerequisite: Twelve hours of psychology, including Psychology 135 or equivalent. BATCHELDER, BOGARTZ, TATSUOKA.

307. Quantitative Methods, II. Continuation of Psychology 306. 1 unit. Prerequisite: Psychology 306. BATCHELDER, BOGARTZ, TATSUOKA.

311. Laboratory in Physiological Psychology. Research in classical and current problems, with emphasis on the nervous and endocrine systems in information processing and in the regulation of behavioral adaptation, with examples from sensation, perception, motivation, emotion, and learning. Laboratory. ½ or 1 unit. Prerequisite: Psychology 211.

323. The Small Social Group. Same as Sociology 323. Theory, observation, and analysis of face-to-face social groups, such as friendships, cliques, clubs, committees, and laboratory and experimental groups. Deals with the characteristics

functions, and forms of interaction of small groups and covers recent theoretical and empirical developments in this field of sociology. ½ or 1 unit. Prerequisite: Sociology or Psychology 201.

326. **Motivation and Emotion.** The nature and development of emotion, attitude, motive, and the role of these processes in social adjustment. ½ or 1 unit. Prerequisite: Six hours of psychology. J. COHEN.

330. **Experimental Psychology, I.** A survey of problems, experimental methods, and research findings in the fields of psychophysics, sensory processes, perception, judgment, and thinking. ½ unit. Prerequisite: Psychology 230 and 235. GREENBERG, HAKE.

331. **Experimental Psychology, II.** A survey of problems, experimental methods, and research findings in the fields of motivation, learning, retention, and work. ½ unit. Prerequisite: Psychology 235 and 248. MONTAGUE.

332. **Research Methods in Social Psychology.** Same as Sociology 332. A lecture and laboratory course in the methods and techniques of social psychological research. Emphasis is given to methods for laboratory experiments on small groups. ½ or 1 unit. Prerequisite: Psychology or Sociology 201; Psychology 235 or Sociology 184 and 185. DAVIS, FISHBEIN, MCGRATH.

335. **Mathematical Formulations in Psychological Theory.** Mathematical formulations are illustrated by studying quantitative treatments of various psychological processes. Emphasis is on learning theory, psychophysical laws, and other selected topics. Simple mathematical tools are developed as required. ½ or 1 unit. Prerequisite: Elementary statistics or probability, elementary calculus, and six hours of psychology, or consent of instructor. BATCHELDER, T. STEINER.

338. **Abnormal Psychology.** An introduction for preprofessional students to the psychological aspects of the behavior disorders, including study of the insanities, psychoneuroses, mental deficiencies, and other conditions. ½ or 1 unit. Prerequisite: Six hours of psychology. D. PETERSON, ULLMANN.

345. **Comparative Psychology.** Animal behavior with particular reference to the behavior of vertebrates. ½ or 1 unit. Prerequisite: Six hours of psychology, or Psychology 100 or 103 and one course in zoology. HIRSCH, MEAD.

346. **Behavior Genetics.** Examination of the relations between genetic mechanisms, population structure, and individual differences in behavior; survey of research and possible extensions of research on the genetics of behavior; laboratory work on techniques of behavior study and genetic analysis. ½ or 1 unit. Prerequisite: Psychology 100 or 103; a course in statistics. HIRSCH.

348. **Theories of Learning.** A survey of the basic theories and approaches to theory construction in learning. ½ or 1 unit. Prerequisite: Psychology 248 or Educational Psychology 211. BATCHELDER, T. STEINER.

350. **Research and Theory in Personality.** The study of personality for the advanced student in psychology; the problems of measurement, development, structure, dynamics, and change of personality are considered; examples of current theory and research are studied as illustrations of an objective approach to the field. ½ or 1 unit. Prerequisite: Psychology 100 or 103; Psychology 235 or equivalent.

351. **Advanced Social Psychology.** Same as Communications and Sociology 351. An integrative treatment of individual behavior variables in relation to group variables. ½ or 1 unit. Prerequisite: Psychology or Sociology 201; Psychology 235, or Sociology 385, or a comparable statistics course. MCGRATH, I. STEINER.

352. **Attitude Theory and Measurement.** Same as Communications and Sociology 352. A comprehensive survey of psychological theories of attitude organization and change, and a theoretical and methodological analysis of the various techniques used to measure attitude. Theories and methods are evaluated with

respect to empirical research in the area. ½ or 1 unit. Prerequisite: Sociology or Psychology 201; a course in statistics. FISHBEIN.

355. Industrial Social Psychology. Same as Labor and Industrial Relations 355. Social psychological research and theory applied to industrial problems. Emphasis upon interaction and communication theory, role theory, leadership theory, motivational and perceptual theory, and group structure theory as an aid in understanding and analyzing industrial problems. ½ or 1 unit. Prerequisite: Psychology 201 or 357. TRIANDIS.

356. Human Factors in Equipment Design. The contributions of psychological research to the design of equipment for efficient human use and operation. Studies of the characteristics and limitations of the human individual which bear upon the equipment and machines best suited to his use. A survey of research on visual and auditory displays, controls, layout of consoles; complex man-machine systems; vigilance and isolation effects; design for efficient trouble-shooting and maintenance. Emphasis is placed upon the methods used in collecting data on these problems. Applications to engineering, industrial design, management, etc., are discussed. ½ or 1 unit. Prerequisite: Psychology 100 or 103; one course in statistics or college mathematics.

357. Psychology of Industrial Conflict. Same as Labor and Industrial Relations 357. An analysis, in terms of behavior of individuals, of the causes and possible solutions of industrial conflict. No credit is given for undergraduate majors in psychology. ½ or 1 unit. Prerequisite: Psychology 100 or equivalent. Offered in special interest of industrial relations, commerce, and engineering students. HULIN, NEALEY.

358. Human Performance in Man-Machine Systems. Examination of equipment and training variables that influence the human operator and the effectiveness of man-machine systems; methods of task analysis for the systematic determination of behavioral requirements; design and use of simulators and other training devices; measurement of operator proficiency; control and display variables in closed-loop tracking systems; motor and perceptual fatigue; effect of work load; contemporary issues. Field trips. Research project on equipment design. ½ or 1 unit. Prerequisite: Psychology 100 or 103; one course in statistics or college mathematics. ADAMS.

359. The Social Psychology of Organization. Same as Sociology 359. Analysis of the interrelationships between social and psychological factors on the one hand and organizational structure and process on the other; emphasis on sources, consequences, and modes of resolution of intra-individual, intra-organizational, and inter-organizational conflict. 1 unit. Prerequisite: Psychology 355 or Sociology 322. MCGRATH.

360. Modern Viewpoints in Psychology. A brief survey of early theoretical psychology followed by an examination of contemporary "behavior theory," Gestalt theory, and psychoanalytic theory—as conceptions of man and as approaches to the study of learning, perception, personality, and social behavior. ½ or 1 unit. Prerequisite: Nine hours of psychology with an average grade of B, or consent of instructor. DULANY.

361. Advanced Developmental Psychology. Theory and research on psychological development from birth through adolescence; maturation of behavior systems; the role of social learning in development; the effects of early experience on personality development; critical stages in development. ½ to 1 unit. Prerequisite: Psychology 216 or 217; a course in statistics. HUNT, SCOTT.

369. Introduction to Human Ecology. Same as Anthropology, Geography, Health Education, Physiology, Sociology, Veterinary Medical Science, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations, and

physiological, psychological, and sociological adjustments to environment, regulation of populations, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology; one year of anthropology, geography, geology, or sociology. SHIMKIN, STAFF.

371. Psychological Factors in Political Behavior. An application of psychological methods and theories to the study of political behavior. Special attention is given to research methods and to content problems in voting behavior and national security policy. ½ to 1 unit. Prerequisite: Six hours beyond 100-level courses in psychology, political science, or sociology.

373. Human Development in Cross-Cultural Perspective. Same as Anthropology 373. The comparative analysis of recurrent problems inherent in the biosocial nature of man, particularly as these are reflected in stages of the life cycle from birth through death. Attention is also given to the cross-cultural study of other selected topics such as illness and health, deviancy, and the handling of aggression. Use is made of materials available on the campus in the Human Relations Area Files. ½ or 1 unit. Prerequisite: Six hours of anthropology, psychology, or sociology, or consent of instructor. CASAGRANDE, MALPASS.

374. Problems in Human Ecology. Same as Anthropology, Geography, Health Education, Physiology, Sociology, and Veterinary Medical Science 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multidisciplinary studies of selected current problems. 1 unit. Prerequisite: Anthropology, Geography, Health Education, Physiology, Sociology, or Zoology 369.

386. Methods of Field Research. Same as Sociology 386. Instruction, training, and supervised practice in methods of field research as a basic tool of psychology. Major emphasis is placed on the role of the field researcher as participant, observer, and interviewer in various kinds of research settings, and on approaches to and applications of field data. Each student develops and executes a field research project dealing with some aspect of institutional, occupation, or general community activity and structure. ½ or 1 unit. Prerequisite: Psychology or Sociology 201; Psychology 235 or Sociology 184 and 185.

390. Psychological Tests and Measurements. The measurement of human behavior in psychological studies; the construction and use of psychological tests; introduction to tests of intelligence, achievement, personality, and interest; practice in test construction, administration, and validation. Lectures and laboratory. 1 unit. Prerequisite: Psychology 235. HULIN, N. WIGGINS.

RADIO AND TELEVISION

The Department of Radio and Television offers work leading to the Master of Science in Radio and Television. For the program leading to the Doctor of Philosophy in Communications, see page 142.

Admission to the program leading to the Master of Science requires (1) completion of the requirements for a bachelor's degree in an institution of recognized standing, preferably with a major (normally twenty semester hours) in radio-television or a related field, English, or the social sciences; (2) a grade-point average of at least 4.0. Applications of students with grade-point averages below 4.0 but above 3.5 are considered on an individual basis.

Master of Science in Radio and Television. Requirements for this degree include: (1) A major of four units or three units and one additional unit approved by the adviser; (2) a minor of at least two units, normally in an area outside the College of Communications; (3) a one-unit thesis or an approved production project; (4) a minimum of three units in courses (including thesis) at the 400 level, at least two of which must be in the major field; (5) a minimum of eight units.

A list of the specific courses that must be included in the Master of Science in Radio and Television degree program is available upon request from the department.

Students are expected to plan their programs around a special interest area which may include television production and direction, television writing, television news, television advertising, cinematography for television, television art, and television scenic design.

GRADUATE FACULTY

Professor: F. E. SCHOOLEY.
Assistant Professor: H. W. LIPPOLD, JR.

COURSES FOR GRADUATES

450. Special Problems in Television. Project work for advanced students in specific areas of television, including news, advertising, directing, writing, etc. ½ to 3 units; a maximum of 3 units is permitted toward degree. Prerequisite: A television course in the area of specialization; consent of instructor. STAFF.

451. Television Program Management and Production. Problems in originating, planning, and producing television programs. 1 unit. Prerequisite: Course or experience in television directing and production; consent of instructor.

462. Seminar in Radio and Television. Same as Communications 462. A study of the performance of radio and television in terms of content, government and industry controls, social responsibility, economic bases, and psychological and social effects. 1 unit.

463. World Broadcasting. Same as Communications 463. A study of the broadcast systems used by the nations of the world; alternative and "mixed" systems; international organizations, agreements, exchanges, and problems; broadcasts to and from other countries; implications of such new developments as satellites; mass and non-mass uses. 1 unit. Prerequisite: Radio and Television 462 or consent of instructor.

490. Special Topics in Radio and Television. ½ or 1 unit. Prerequisite: Consent of head of department. STAFF.

499. Thesis Research. 1 to 2 units. Prerequisite: Graduate standing in radio and television. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

354. Television Directing. The theory and techniques of directing the television program. Experience in directing laboratory productions. ½ unit. Prerequisite: Radio and Television 252; consent of head of department.

355. Television News. News coverage, script preparation, use of visual materials, and presentation of news programs. Attention given to interviews, special events, and news fields of special interest. ½ unit. Prerequisite: Consent of instructor. LIPPOLD.

356. Cinematography for Television. The equipment and techniques used in the production of films for television, including camera operation, lighting, editing, sound recording, matching, etc. Materials cost approximately $50.00. ½ unit. Prerequisite: Consent of instructor.

357. Broadcast Continuity Writing. A study of the fundamentals of radio and television continuity writing, including commercial copy, talks, interviews, music, and feature programs. ½ unit. Prerequisite: Consent of instructor.

360. Educational Uses of Television and Radio. Same as Communications and Educational Psychology 360. A study of television and radio as educational instruments, and standards necessary for such use; production, utilization, planning, and evaluation; primary and secondary uses. Identification of the unique contributions and resources of the electronic media, as well as their limitations. Experimentation into new production and utilization techniques designed for educational uses. ½ unit.

362. Radio and Television Station Management. A study of the organization and administration of the radio and television staff and station; public relations, personnel management, and station operation; analysis of station and agency relationships and radio and television sales procedure; methods and media for program and station promotion; laws and regulations affecting management, financing, and labor relationships. ½ unit. Prerequisite: Radio and Television 261. SCHOOLEY.

363. Advanced Dramatic Writing. Same as Speech and English 363 and Theatre 380. Application of principles of dramatic form and structure to the more complex problems of playwriting. Practice in writing sustained dramatic forms. ½ or 1 unit; students may accumulate 2 units of credit. Prerequisite: Speech 263 or equivalent; consent of instructor. SMALLEY.

365. Radio News. News writing and editing for broadcasting; radio news style; preparation and practice for special event reporting; commentaries and interpretations; radio news services, and processing radio news service copy. ½ unit. Prerequisite: Journalism 211. CRAMER.

366. Advanced Radio and Television Practices, I. Project work for advanced students in selected areas of radio and television, including news, advertising, announcing, production and direction, and writing. ½ unit. Prerequisite: All courses in area of specialization; consent of instructor. STAFF.

367. Advanced Radio and Television Practices, II. Continuation of Radio-Television 366. ½ unit. Prerequisite: All courses in area of specialization; consent of instructor. STAFF.

368. Radio and Television Regulation. Federal legislation, with emphasis on the Communications Act of 1934 and the regulations of the Federal Communications Commission, legal problems in program operation, censorship and editorial selections, copyright, and author-producer relations. ½ unit. SCHOOLEY.

RECREATION AND PARK ADMINISTRATION

The Department of Recreation and Park Administration offers a program of graduate study leading to the Master of Science in Recreation. (For information regarding the degree of Doctor of Philosophy in Physical Education with specialization in recreation, see page 340.) This program primarily prepares leaders, supervisors, administrators, teachers, and research workers in community recreation, but it also offers opportunities for preparation in the related fields of park administration, therapeutic recreation and rehabilitation, outdoor recreation, and college union administration, as well as recreation work with private agencies, business and industry, commercial recreation enterprise, etc.

Admission requirements for a major in this field are (1) a minimum grade-point average of 3.5 for the last sixty semester hours; (2) thirty semester hours of approved undergraduate credit in recreation or closely allied courses; (3) fifteen semester hours in the social and psychological sciences; (4) eight semester hours of undergraduate credit in the natural sciences; and (5) a course in statistics or tests and measurements.

Requirements for this degree are eight units including: (1) four units in recreation or approved courses; (2) two units of approved electives; (3) registration

in and satisfactory completion of Recreation 490; and (4) thesis, two units. The thesis requirement may be waived upon approval of a petition, but the student may substitute two additional units of course work and pass a comprehensive examination.

GRADUATE FACULTY

Professors: A. V. Sapora (Head of Department).
Associate Professor: H. E. Weaver.
Assistant Professors: D. W. Bishop, M. J. Ellis, M. Virginia Frye.

COURSES FOR GRADUATES

401. Foundations of Recreation. Basic philosophical, historical, and scientific foundations and developments in leisure and recreation; analysis of recreation values as related to other contemporary individual and community needs; functions and settings of organized recreation, special problem areas, and current issues. 1 unit. Prerequisite: Recreation 176 or equivalent.

402. Recreation Administration. Designed to strengthen the graduate student's knowledge of the public administration of recreation programs and services provided by municipal, county, state, and national departments and agencies and as related to the general well-being of individuals, families, and communities. 1 unit. Prerequisite: Basic courses in the organization of recreation, or equivalent.

403. Evaluation of Recreation Resources and Programs. Methods and techniques of determining recreational needs, interests, and opportunities of individuals and communities through surveys, studies, and appraisals; evaluating and appraising community recreation programs and services; research in the field of recreation. 1 unit. Prerequisite: Recreation 176 or 375, or equivalent; a course in tests and measurements or statistics. Sapora.

404. Outdoor Education and Recreation. Philosophy, essential principles, methods, techniques, resources, administrative and program practices for outdoor education and recreation. 1 unit. Prerequisite: Recreation 174 or equivalent; one undergraduate course in biology, botany, geology, or zoology. Weaver.

490. Seminar. Student presentation of thesis studies, informal discussions, and critical analysis of problems; informal lectures by invited speakers. No credit. Staff.

493. Special Projects. Independent research on special projects. Open only to students majoring in recreation. ½ to 2 units. Prerequisite: Recreation 403 or equivalent Staff.

499. Thesis Research. Preparation of thesis in recreation. 0 to 4 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

375. Introduction to Administration. Organization of public and private agency programs, leadership, facilities and services; introduction to recreation administration. ½ or 1 unit. Prerequisite: Recreation 176. Johns, Sapora.

385. Park Management. An intensive study of the principles, practices, and problems involved in managing public park systems. Designed to provide a professional background including the history of parks, organization, planning examination of facility design and layout, maintenance, finance, and operation of park systems. ½ or 1 unit. Prerequisite: Landscape Architecture 226, Urban Planning 171, Political Science 305, Recreation 278 and 279, or equivalent Johns, Owens.

390. **Principles of Therapeutic Recreation.** Concepts, principles, objectives, methods, and settings of recreation for the ill and handicapped. ½ or 1 unit. Prerequisite: Recreation 176 and 208 or 209, or consent of instructor. FRYE.

395. **Recreational Use of Public Lands.** A study of lands in the public domain, and their historical, current, and potential use for outdoor recreation. It includes an analysis of land, woods, and water in the public domain; the demand for outdoor recreation; multiple use concept of natural resources; functions and policies of federal and state governments and their agencies; the economics of outdoor recreation; and the future of outdoor recreation in America. ½ or 1 unit. Prerequisite: Recreation 176, Geography 214, and Economics 108, or consent of instructor.

RUSSIAN LANGUAGE AND AREA STUDIES

Graduate programs in Russian language and area studies are offered by the Russian and East European Center in cooperation with various departments.

Minor for the Master's Degree. A candidate for the master's degree who elects Russian language and area studies as a minor must earn at least two units of graduate credit in courses chosen from the following: anthropology, economics, geography, history, law, library science, political science, Russian, and sociology. The courses chosen must be in at least two departments.

Minor for the Doctor of Philosophy Degree. A doctoral candidate who elects Russian language and area studies as a minor must demonstrate a reading command of Russian as tested by examination or by completion of Russian 104 or 401 with a grade of A or B, and in addition must earn at least four units of graduate credit in courses chosen from the list given just above. The four units must include courses from at least two departments outside of, and may at the same time include up to one unit from within, the department offering the candidate's major.

Certificate of Graduate Specialization in Russian Language and Area Studies. This certificate is awarded by the Graduate College and the Russian and East European Center. It is for persons with the baccalaureate who are enrolled in advanced studies in any discipline and who wish at the same time to gain a knowledge of the Russian area and language. The requirements are: (1) A good command of written and spoken Russian, as determined by special examinations, or a grade of A or B in Russian 104 or 401. (2) At least six graduate units relating to Russia, distributed among at least three of the departments represented in the program (anthropology, economics, geography, history, law, library science, political science, Russian, and sociology) other than the student's own major department. If the student's major department is one of these nine he may count, as part of his six units, up to one unit from within his major department. (3) A special essay based largely on Russian sources, which must meet, at the minimum, the standard normally required in a master's thesis. The student may submit, in fulfillment of this requirement, a copy of his master's thesis or doctoral dissertation.

The adviser for the graduate minors and the Certificate is Professor Ralph T. Fisher, Jr., Director of the Russian and East European Center, 1207 West Oregon Street, Urbana.

GRADUATE FACULTY

Professors: R. T. FISHER, JR. (Director of Russian and East European Center), C. L. DAWSON, J. D. FELLMANN, D. R. HODGMAN, E. G. LEWIS, TEMIRA PACHMUSS, D. B. SHIMKIN, A. VUCINICH.
Associate Professors: E. C. BRISTOL, K. A. HITCHINS, K. KLEIN, P. B. MAGGS.
Assistant Professors: R. DUNATOV, F. Y. GLADNEY, S. P. HILL, T. M. LIGHTNER, J. R. MILLAR.

SLAVIC LANGUAGES AND LITERATURES

(Including Czech, Russian, Slavic, and Ukrainian)

The Department of Slavic Languages and Literatures offers graduate work leading to the Master of Arts in Russian, Master of Arts in the Teaching of Russian and Doctor of Philosophy in Russian literature or Slavic linguistics.

Students with a minimum grade-point average of 4.0 are regularly admitted to graduate courses, subject to fulfillment of other prerequisites. Students with a grade-point average between 3.75 and 3.99 are admitted upon approval of the department.

Students electing Russian as a major subject should have had the equivalent of at least four years of Russian in college, including practical work in the use of the language and an advanced course in literature.

Students choosing Russian as a minor subject should consult the department.

Master of Arts in Russian. In addition to fulfilling the general requirements of the Graduate College, candidates must pass both a written and an oral examination. Students may major in literature or linguistics and may offer a minor. Students majoring in literature must present at least two courses in linguistics; those majoring in linguistics must present at least two courses in literature.

Master of Arts in the Teaching of Russian. All candidates for this degree are required to take: (1) Russian, five units: up to three units from 300-level courses and at least two units from courses open only to graduates; (2) education, two units including Educational Psychology 311 and 312 and two of the following: History and Philosophy of Education 303, 304, 305; (3) electives, one unit. These courses must be selected with the approval of the adviser. Candidates must pass an examination based on their course work and on a reading list. See pages 38 and 39

Doctor of Philosophy in Russian. All candidates for this degree must fulfill the general requirements of the Graduate College and must have a reading knowledge of French and German. A student may major in literature or linguistics, and may offer a minor, preferably in another language or literature, comparative literature or linguistics. Those students majoring in literature must present at least four courses in linguistics, as well as training in another Slavic language; students majoring in linguistics must present at least four courses in literature, along with some training in two other Slavic languages.

GRADUATE FACULTY

Professors: C. L. Dawson (Head of Department), Temira Pachmuss.
Associate Professors: Evelyn Bristol, K. Klein.
Assistant Professors: R. Dunatov, F. Y. Gladney, S. P. Hill.

Czech

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

383. The Structure of Modern Czech. Analysis of the sound system and grammar of the contemporary Czech language with some reference to its historical development. ¾ unit. Prerequisite: Knowledge of another Slavic language, preferably Russian, or consent of department.

384. Readings in Czech Literature. Representative works of modern Czech literature and their historical and cultural background. ¾ unit. Prerequisite: Czech 383 or consent of department.

Russian

COURSES FOR GRADUATES

400. **Beginning Russian for Graduate Students.** Basic grammar and vocabulary, introduction to the reading of Russian texts in the sciences and the humanities. Designed for graduate students preparing to offer a reading knowledge of Russian for the Ph.D. No credit.

401. **Readings in Russian for Graduate Students.** Reading and translation of general and individually specialized materials, to increase speed, accuracy, and vocabulary. Designed for graduate students preparing to offer a reading knowledge of Russian for the Ph.D. No credit. Prerequisite: Russian 400 or equivalent.

406. **Russian Morphology.** A survey of the various parts of speech of modern standard literary Russian with special emphasis on the nominal and verbal systems. 1 unit.

407. **Russian Syntax.** A survey of historical and contemporary Russian syntax. 1 unit. Prerequisite: Consent of instructor or head of department.

408. **Russian Phonology.** Same as Linguistics 408. Synchronic examination of the phonological system of modern Russian and of its interrelation with the syntactic and lexical systems; brief discussion of the historical development of the phonological system. 1 unit. Prerequisite: Consent of instructor.

410. **Old Russian Literature.** Reading and analysis of texts with historical and literary commentary. 1 unit. Prerequisite: Slavic 405.

412. **Literature of the Eighteenth Century.** Reading of texts. Historical and literary background of the period. 1 unit.

414. **Pushkin.** The age of Pushkin; Pushkin's works in historical and comparative perspective; textual criticism, linguistic and structural analysis, intellectual interpretation, and aesthetic evaluation. 1 unit. Prerequisite: Consent of instructor or head of department.

415. **Dostoevsky.** Dostoevsky: historical background, textual analysis, structure, philosophy and ideology, and aesthetic evaluation. 1 unit. Prerequisite: Consent of instructor or head of department.

416. **Studies in Russian Criticism.** 1 unit. Prerequisite: Consent of instructor or head of department.

417. **History of the Russian Language.** 1 unit. Prerequisite: Slavic 405.

419. **Tolstoy.** Tolstoy: historical background, textual analysis, structure, philosophy and ideology, and aesthetic evaluation. 1 unit. Prerequisite: Consent of instructor or head of department.

420. **Chekhov.** Chekhov: historical background, textual criticism, structural analysis, philosophy and ideology, and aesthetic evaluation. 1 unit. Prerequisite: Consent of instructor or head of department.

421. **Seminar in the Russian Novel.** Dostoevsky, Tolstoy, nineteenth-century novel, twentieth-century novel. 1 unit. May be repeated for a total of 3 units. Prerequisite: Consent of instructor or head of department.

422. **Russian Literature in Exile.** Bunin, Merezhkovsky, Kuprin, Zaitsev, Remizov, Teffi, Aldanov, Shmelev, Z. Hippius, V. Ivanov, Xodasevich, Tsvetaeva, Varshavsky, Odoevtseva, G. Ivanov, Adamovich—prose writers, poets, and critics. 1 unit.

423. Seminar in Russian Poetry. Pushkin, narrative verse, lyric verse, symbolism. Course may be repeated for credit not to exceed 3 units. 1 unit. Prerequisite: Russian 337 or consent of department.

424. Gogol. Historical background, textual criticism, structural analysis, philosophy and ideology, and aesthetic evaluation. 1 unit. Prerequisite: Consent of instructor or head of department.

425. Seminar in Russian Drama. Intensive analysis and discussion of specific genres, periods, and dramatists in the light of dramatic theories. The subject of the course varies each year. 1 unit. May be repeated for a maximum of 3 units. Prerequisite: Russian 335 or consent of department.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. Advanced Reading and Conversation, I. Practice in conversation with a native speaker, based on reading materials from Russian literature and culture. ½ unit. Prerequisite: Three years of college-level Russian.

307. Structure of Russian. The morphology, syntax, and lexicon of modern Russian, contrasted with English, with attention to problems of teaching. ¾ unit. Prerequisite: Russian 212 and 214.

308. Russian Phonetics and Pronunciation. Study of the Russian sound system; training in the improvement of pronunciation and intonation. ¾ unit. Prerequisite: Russian 212 or consent of instructor.

313. Advanced Russian Composition. Practice in advanced composition and study of advanced problems of grammar, syntax, and style. ¼ unit. Prerequisite: Three years of college Russian, including Russian 213 and 214, or consent of instructor

317. Soviet Literature in Translation. Survey of Russian literature since the 1917 Revolution; cultural and historical background of the period. No knowledge of the Russian language is required. ¾ unit. Prerequisite: Junior standing or consent of instructor.

321. Russian Literature from 1810 to 1845. Representative works of the period, with emphasis on Pushkin, Lermontov, and Gogol. ¾ unit. Prerequisite: Russian 216, or consent of instructor.

322. Dostoevsky and Tolstoy. Representative works in their historical and cultural contexts. ¾ unit. Prerequisite: Russian 216 or consent of instructor.

323. Russian Literature 1845 to 1880. Representative works of the period, with emphasis on Turgenev, Goncharov. ¾ unit. Prerequisite: Russian 216 or consent of instructor.

324. Russian Literature from 1880 to 1917. Representative works of the period, with emphasis on Chekhov, Gorky, and Blok. ¾ unit. Prerequisite: Russian 216 or consent of instructor.

325. Soviet Russian Literature. Representative works of Russian literature since 1917: Mayakovsky, Leonov, Sholokhov, and others; historical and cultural backgrounds. ¾ unit. Prerequisite: Russian 216 or consent of instructor.

326. Masterpieces of Russian Literature. Masterpieces of Russian literature: historical background, textual analysis, structure, philosophy and ideology, aesthetic evaluation. ¾ unit. Prerequisite: Russian 216 or consent of instructor.

332. Traditions of Russian Literature and Thought. The rise and development of Russian social and philosophical thought in the nineteenth century and its impact on literature. ¾ unit. Prerequisite: Consent of instructor.

333. **The Russian Short Novel.** Theory and techniques of the *povest'* and related forms in the nineteenth and twentieth centuries. S; ½ unit. Prerequisite: Russian 216 or consent of instructor.

335. **Russian Drama.** Historical survey of Russian dramatists and their works: from the origins in folk and liturgical playlets, through classicism, Gogol, Ostrovsky, Chekhov, and Stanislavsky, to Meierhold and the Soviet drama. 1 unit. Prerequisite: Russian 216 or equivalent.

337. **Russian Poetry.** A study of significant Russian poets and their works from Zhukovsky through the twentieth century. 1 unit. Prerequisite: Russian 216 or equivalent.

Slavic

COURSES FOR GRADUATES

405. **Old Church Slavonic.** Analysis of grammar, reading of texts, discussion of development of the Slavic languages. 1 unit. Prerequisite: Slavic 380.

418. **Oral Poetry and Slavic Poetics.** Linguistic material and poetic form. Oral poetry in its genres, motifs, and themes; their unit and diversity in the cultural history of Slavic peoples; the impact of oral poetry on literary tradition. 1 unit.

460. **Comparative Slavic Phonology.** The phonological structure of Common Slavic at the time of dissolution of the primitive Slavic community; the characteristic tendencies in the evolution of sound and prosodic systems in the East, West, and South Slavic language groups; the phonemic patterns of single modern Slavic languages outlined as a basis for a typological classification of Slavic languages. 1 unit. Prerequisite: Slavic 380.

461. **Comparative Slavic Morphology.** A lecture course designed to trace the development of the principal parts of speech, their various inflectional and derivational morphemes and their attendant grammatical categories from Common Slavic to the various modern Slavic languages, and to make comparisons among the modern synchronic morphological treatments of these languages. 1 unit. Prerequisite: Slavic 460.

491. **Individual Topics.** ¼ to 2 units. Prerequisite: Graduate standing with a major or minor in Russian.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

331. **Slavic Civilization and Literatures.** A survey of Slavic institutions and life as reflected in Slavic literatures other than Russian (Polish, Czech, Ukrainian, etc.) and their connection with Russian traditions. ¾ unit. Prerequisite: Reading knowledge of Russian or one other Slavic language, or consent of instructor.

380. **Introduction to Slavic Linguistics.** Same as Linguistics 380. Changes in phonology and morphology from Indo-European to Common Slavic; geographical distribution of Slavic languages and dialects, prehistory and early history of the Slavs, and Balto-Slavic linguistic relationships. ¾ unit.

382. **Language Laboratory Techniques.** Same as French, German, and Spanish 382. Instruction and practice in the techniques of making foreign-language tapes and integrating them with classroom activity; instruction in the problems of

planning and operating a language laboratory. S; ½ unit. Prerequisite: Three years of a modern foreign language at the college level, or equivalent.

394. Introduction to Folklore: History, Theory, Methods. Same as Comparative Literature, English, and German 394, and Speech 346. An introduction to the study of folklore with emphasis on folk cultures in the Old and New World; an historical survey of the development of folklore study, an analysis of the methods and genres of folklore, and an introduction to field collecting and evaluation of archival materials. ¾ unit. Prerequisite: A reading knowledge of one modern foreign language is recommended.

Ukrainian

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

396. The Structure of Ukrainian. Ukrainian phonology, morphology, and syntax presented with Russian as a background and basis for comparison of these two East Slavic languages. ¾ unit. Prerequisite: Russian 104 or equivalent.

398. Readings in Ukrainian Literature. Representative works of Ukrainian literature and their historical and cultural background. ¾ unit. Prerequisite: Ukrainian 396 or consent of instructor.

SOCIAL SCIENCES

Master of Arts in the Social Sciences. A special program leading to the Master of Arts in the Social Sciences is offered to students through the Division of Social Sciences (including anthropology, economics, geography, history, philosophy, political science, psychology, social work, and sociology). This program is designed to meet the needs of students who plan to teach the social sciences and the needs of those who wish to study in several related fields within the social sciences rather than to specialize in one department. To qualify for this program a student must have a grade-point average of at least 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

The Master of Arts in the Social Sciences requires a major of four units and a minor or double minor totaling four units. No minor may be less than two units. At least three of the eight units required for this degree must be in 400-level courses with at least two of these three units in the major. The student's work is directly supervised by an advisory committee, composed of two or three members, one for each field of study forming a major or minor. The representative of the major field is the chairman of the committee. As part of his work in the major field, each student is required to write an essay under the direction of the chairman of the committee and subject to his approval. Work upon this essay may constitute, through registration in research courses, part of the four units of work required for the major. At the completion of his studies the student must pass an oral comprehensive examination given by the committee as a whole.

The Chairman of the Division of Social Sciences is Professor John Thompson, 222 Davenport Hall. The general adviser for this degree is Professor George Manner, 384 Lincoln Hall.

Master of Arts in the Teaching of Social Studies. Candidates for this degree who hold secondary school social studies certificates may complete requirements with eight units of graduate work. Four units are to be in the social studies (two of these must be in history); three units are in advanced education (Educational Psychology 311 and 312, History and Philosophy of Education 304 and 305, and Secondary and Continuing Education 456); and one unit is an elective chosen in consultation with the adviser.

Potential candidates who are not certified may be admitted with deficiencies. ıch individuals must satisfy the requirements for an Illinois secondary school social udies certificate as well as the general degree requirements outlined above.

The grade-point average required for admission is 3.75. Applications of students ith grade-point averages below 3.75 but above 3.5 are considered on an individual asis. See pages 38 and 39.

The adviser for candidates for this degree is Professor Robert A. Waller, 315 ırmory. Additional information may be secured by writing him.

OCIAL WORK

The Jane Addams Graduate School of Social Work offers two years of graduate rofessional study leading to the Master of Social Work. Although the basic urriculum of the School is the same for all students, there are opportunities for pecialization in casework and group work. Students specializing in group work have heir classes on the University of Illinois Chicago Circle campus and field placenents in group work agencies in the city. Those specializing in casework may have lasses on either the Urbana or Chicago campus, with field placements in selected igencies nearby.

The School has established an admissions committee which is responsible for eviewing all applications. The committee's scrutiny of scholastic achievement is lirected principally to the applicant's record in the social sciences and pre-profesional social work courses, and in those courses which reveal mastery of the English anguage. A minimum of twenty hours in social science courses is required. The applicant must give evidence of ability to carry graduate work.

In addition to scholastic achievement, the admissions committee attempts to determine the applicant's personal suitability for professional education in social work. Admission is granted only to the applicant whose health is sufficiently good to permit his undertaking a study program which taxes physical energy. The applicant must also show evidence of emotional maturity commensurate with his age and past experience; interest in and liking for people, and ability to establish harmonious and healthful relationships; and personal integrity as demonstrated by intellectual honesty and a sense of responsibility. Serious deficiencies in these areas disqualify an applicant.

The School is compelled to limit enrollment to the number of field work placements available.

The courses listed on page 382 describe the program offered on the Urbana campus. Similar courses are offered in Chicago under a quarter term calendar, and the group work sequence is offered only there. For information about the Chicago program, the School's special catalog should be consulted.

Application must be made to the Jane Addams Graduate School of Social Work. The special catalog issued by the School may be obtained by writing to the Director, Jane Addams Graduate School of Social Work, University of Illinois at Urbana-Champaign, 1207 West Oregon Street, Urbana 61801.

GRADUATE FACULTY

Professors: M. P. Hale (Director of the Jane Addams Graduate School of Social Work), Jennette R. Gruener, F. H. Itzin, D. E. Lathrope, Florence L. Poole, W. P. Simon, M. A. Taber, L. Jane Wille.

Associate Professors: Lela B. Costin, A. Dinwoodie, Margaret G. Holden, G. W. Magner, J. E. McDonald, Aleanor R. Merrifield, Mary E. Sullivan, N. Viswanathan.

Assistant Professors: Eloise J. Cornelius, S. Mirelowitz, Naomi L. Tillman, H. Treger.

COURSES FOR GRADUATES

421. Social Casework, I. Analysis and study of philosophy, concepts, principles, and methods of social casework; role of caseworker in offering service; psychological and cultural factors affecting treatment; analysis of relationship, study-diagnosis, and treatment. ½ to 1 unit.

422. Social Casework, II. Casework principles and methods with emphasis on work with clients with complex emotional and personality problems; the stresses which impair social and ego functioning; the effects of agency setting. Casework methods as adapted to treatment of children and their parents, adults, the neurotic and mentally ill, the delinquent; multiple client interviewing and family diagnosis and treatment. ½ to 1 unit. Prerequisite: Social Work 421.

425. Group Process and Method. Small group theory and the group process; the use of group process and methods in social work practice. ½ to 1 unit.

426. Social Planning and Administration. Principles, concepts, and methods of planning and administration of social services; emphasis on leadership, policy and decision making, and program organization. ½ to 1 unit.

427. Social Research. Objectives of social research, design of experiments, and measurement and methods of collecting data; design of questionnaires and schedules; methods of data analysis including statistical hypothesis testing and applications of inferential techniques; interpretation of results; preparation of reports. ½ to 1 unit.

431. Practice Seminar, I. Critical examination of the application of knowledge to social work practice; emphasis on reciprocal relationships between personal problems and needs, social environment, agency services, and helping methods; consideration of new trends in practice and empirical knowledge. 1 unit. Prerequisite: Consent of instructor.

432. Practice Seminar, II. Critical examination of the application of knowledge to social work practice; emphasis on relationships between personal problems, social problems, planning processes, and agency purposes and functions; consideration of trends in social policy and empirical knowledge. 1 unit. Prerequisite: Consent of instructor.

451. Human Growth and Behavior, I. The major forces influencing the growth and behavior of the individual from birth through adulthood; sociocultural, familial, physical, emotional, and intellectual factors as they enhance or retard social functioning; the nature and dynamics of social process as related to growth and behavior; the relevance of this content to social work practice. ½ to 1 unit.

452. Human Growth and Behavior, II. Inter-relationship of physical, emotional, and social aspects of selected diseases, and implications for the patient, family, and community; psychopathology, including neuroses, psychoses, character disorders, psychosomatic dysfunction, organic conditions, and mental retardation; diagnosis and treatment methods, including psychotherapy, somatic and drug therapies, and social work. ½ to 1½ units. Prerequisite: Social Work 451.

461. Special Studies in Social Work, I. Independent or group study in areas of special interest; application of social work principles to special problems or settings. ½ to 2 units.

462. Special Studies in Social Work, II. Independent or group study in areas of special interest; application of social work principles to special problems or settings. ½ to 2 units.

466. Field Instruction, I. The student is assigned to field instructors for learning experiences in social agencies and communities. Such experiences include the use of knowledge and understanding in analyses of case and problem situations and in direct service to agency clientele. ½ to 1 unit. Prerequisite: Consent of instructor.

467. Field Instruction, II. The student is assigned to field instructors for learning experiences in social agencies and communities. Such experiences include the use of knowledge and understanding in analyses of case and problem situations and in direct service to agency clientele. ½ to 1 unit. Prerequisite: Consent of instructor.

468. Field Instruction, III. The student is assigned to field instructors for learning experiences in social agencies and communities. Such experiences include the use of knowledge and understanding in analyses of case and problem situations and in direct service to agency clientele. 1 to 2 units. Prerequisite: Consent of instructor.

469. Field Instruction, IV. The student is assigned to field instructors for learning experiences in social agencies and communities. Such experiences include the use of knowledge and understanding in analyses of case and problem situations and in direct service to agency clientele. 1 to 2 units. Prerequisite: Social Work 422, 466, 467, and 468.

481. Social Services and Welfare Policy, I. The function, nature, and scope of the social welfare institution; the social services as a response to social, personal, and economic problems of people; effects of economic and social growth and change on the welfare enterprise; current provisions of money aid programs and services for the aged, children, court wards, and the mentally and physically ill. 1 to 1½ units.

482. Social Services and Welfare Policy, II. Critical evaluation of current social services and welfare policy issues and alternatives for their solution; methods of planned change in the resolution of policy issues. ½ to 1 unit. Prerequisite: Consent of instructor.

491. Research Seminar. Seminar for students preparing research projects, either in groups or individually. Experience in the application of research methods to current social work problems. 0 to 2 units. Prerequisite: Consent of instructor.

492. Seminar on Models for Directed Change. Same as Sociology and Urban Planning 492. Construction and analysis of models for planned intervention at the personal, small group, and community levels. Construction of models as interpretations of behavioral science theory; extrapolating of hypotheses and of guides to intervention from the models. Readings from several disciplines as relevant. ½ or 1 unit. Prerequisite: Consent of instructor.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Methods of Social Work Intervention. Examination of the methods of social work intervention (casework, group work, and community organization) utilized in various social work agencies and social welfare settings. Understanding of the values, knowledge, principles, and processes of social work practice is emphasized. ½ to 1 unit. Prerequisite: Credit or registration in Social Work 226.

316. Social Services for Children. Child welfare practice in relation to the state's responsibility for guardianship, the juvenile court, employment, and regulation of child-care facilities; an examination of services which support, supplement, or substitute for parental care of children; consideration of trends and issues in

child welfare planning. ½ to 1 unit. Prerequisite: Credit or registration in Social Work 300, or consent of instructor.

318. Special Problems. A small group seminar for independent study of a topic(s) of special interest to the field of social welfare. Emphasis is on examination and discussion of significant and current social welfare issues and problems. ½ to 1 unit. Prerequisite: Credit or registration in Social Work 300.

333. Introduction to Social Group Work. Background information regarding the place and development of social group work. Attention is given to the nature of groups in society, the development of group work services, concepts of group leadership, and the nature of group activities. Material is presented through lecture and discussion with illustrations from the field of practice in informal education, recreation, and social group work. ½ unit. Prerequisite: Introductory courses in sociology, psychology, and social sciences.

SOCIOLOGY

The Department of Sociology offers graduate work leading to the Master of Arts and Doctor of Philosophy.

In order to be considered for admission, students intending to major in sociology must offer:

(1) A grade-point average of at least 4.0. Applicants with averages between 3.75 and 4.0 are considered on an individual basis;

(2) A minimum of nine semester hours of undergraduate work in sociology;

(3) One or more courses in quantitative research methods in sociology;

(4) Fifteen semester hours in one or more of the following subjects: anthropology, economics, history, mathematics, philosophy, political science, and psychology. Training in logic, philosophy of science, mathematics, and statistics is strongly recommended for students expecting to do graduate work in sociology.

Applicants must submit Graduate Record Examination scores on the tests of verbal ability, quantitative ability, and on the Advanced test in sociology.

The prerequisite for a graduate minor in sociology is six hours of undergraduate work in sociology. Students intending to take a minor in sociology must obtain the approval of a department adviser.

Master of Arts. Candidates for the degree of Master of Arts must earn ten units of graduate credit, including Sociology 385, 386, and 400, or equivalent. They must also pass the departmental comprehensive examination on the master's level.

Doctor of Philosophy. Study for the doctorate must include Sociology 385, 386, 387, and 400, or equivalent. Information on additional requirements, including the language requirement, is given in the department manual for graduate students.

GRADUATE FACULTY

Professors: Rita Simon (Head of Department), D. Bordua, B. Farber, F. C. Fliegel, C. L. Folse, J. E. Hulett, Jr., N. G. Jacobs, H. M. Johnson, B. Karsh, A. Vucinich.

Associate Professors: K. W. Dickman, G. R. Lueschen, S. Sudman, H. Y. Tien.

Assistant Professors: S. Kronus, G. F. Summers.

COURSES FOR GRADUATES

400. General Sociology. Systematic sociology, with emphasis on the development and problems of modern structural-functional theory. Analysis of the works of major contributors to functionalism, e.g., Durkheim, Weber, Merton, and

Parsons, and an examination of the ways in which their work converges to form a cumulative body of sociological theory. 1 unit. JOHNSON.

407. Population Studies and Demographic Analysis. Same as Rural Sociology 407. Nature and development of population theories; population growth and measures of fertility, reproduction, mortality, morbidity, and internal migration; indices, rates, and standardizations used in analyzing compositional characteristics. Methods in population projections, relationship of economic, sociological, and psychological factors to population changes. 1 unit. Prerequisite: Twelve hours of social science and introductory statistics, or major in sociology, or consent of instructor. FOLSE.

408. The Sociology of Human Fertility. Comparative studies of levels of fertility in different societies and in the same societies at different times. Analysis of sociological, psychological, and demographic factors affecting human reproduction and family planning, and consequences of differentials in fertility. 1 unit. Prerequisite: Graduate standing or consent of instructor. TIEN.

409. Psychological Scaling. Same as Psychology 409. Scaling theory and methodology, with emphasis upon measurement in psychophysics, differential psychology, and social psychology. 1 unit. Offered in 1970-1971 and in alternate years. Prerequisite: Psychology 307. TUCKER.

411. Sociology of Science. Social factors in the origin of broad theoretical orientations in science, such as the mechanistic doctrine, vitalism, historicism, atomism, holism, relativism, and indeterminism; social effects of these orientations; the social origin of scientists; ethos of science; the relationship of science to culture change; the variety and nature of scientific institutions. 1 unit. Prerequisite: Sociology 311 or consent of instructor. VUCINICH.

412. Seminar on Social and Cultural Relations of Personality. Problems of theory, concepts, and methodology in the study of the relationship of individual personality and social behavior to culture and social organization. The course is based on a critical examination of the literature and touches on special aspects of the basic problem such as levels of culture, family and class structure, behavior disorders, and social change in relation to the individual. 1 unit. HULETT.

413. Computer Applications in Social Statistical Research. Same as Computer Science and Psychology 413. Computer procedures for the analysis of sociological and psychological data, including probability matrices, dominance matrices, clique analysis, regression analysis, analysis of variance and covariance, canonical correlations, discriminant analysis, and factor analysis. 1 unit. Prerequisite: Sociology 387 or equivalent in statistics; may be taken concurrently with Sociology 387. DICKMAN.

414. Seminar on Social Interaction. Same as Communications 414. An analysis of social interaction based on the social psychology of C. H. Cooley, G. H. Mead, and W. I. Thomas. Problems of theory, concepts, and method. 1 unit. Prerequisite: One unit of graduate credit in sociology. HULETT.

417. Seminar in the Sociology of Law. Review and analysis of selected areas of theory and research in the sociology of law. The focus varies from year to year. Topics covered in different years include such areas as civil litigation and the civil courts, police operations and the sociology of law and order, sociological theories of justice and the operations of legal agencies. Students should consult the instructor about the area to be covered in a particular semester. 1 unit. Prerequisite: Sociology 317. BORDUA, SIMON.

418. Seminar in Industrial and Economic Sociology. Same as Labor and Industrial Relations 418. Discussion and individual research on such topics as industriali-

zation, labor-management relations as group relations, the interrelations of industry and community, technology and the structure of controls in industry, and the problem of a social economics. 1 unit. Prerequisite: Sociology or Labor and Industrial Relations 318, or consent of instructor. KARSH.

421. **Seminar on Research in Marriage and Family Life.** Analysis of relationships between research methodology and conceptual schemes employed to study family life; critical examination of typical studies which illustrate alternatives in the conceptualization of family interaction and the nature of the family unit. 1 unit. Prerequisite: Consent of instructor. FARBER.

422. **Theory of Social Groups.** A comparative survey of selected conceptual systems currently used for the analysis of human groups. The systems are examined with a view to determining the origins and referents of the concepts, their interrelations, and their utility as sources of testable generalizations relevant to the solution of empirical problems in group analysis. 1 unit. DENZIN.

424. **Sociological Analysis of Treatment Institutions.** Analysis of research on the social structure of prisons, training schools, and mental hospitals; sociological approaches to measuring the effects of innovations in institution organization and program; measuring the influence of institutional experience on the post-release behavior of its inmates. Class makes one or more trips to institutions; total travel costs per student for the term not to exceed $10.00. 1 unit. Prerequisite: Sociology 324 and 333, or consent of instructor. DENZIN.

425. **Racial and Cultural Minorities.** A study of the factual and conceptual aspects of minority status as determined by racial and cultural criteria. 1 unit. Prerequisite: Undergraduate major or minor in sociology or anthropology.

426. **Sociological Research on the Extramural Treatment of Deviant Behavior.** Analysis of sociological research on community programs for the treatment and prevention of deviant behavior, including adjudication and disposition in delinquency and mental disorder, probation, parole, out-patient and day- or night-only care, work-release, community correctional treatment. Class makes one or more trips to observe field research; total travel cost for the term not to exceed $10.00. 1 unit. Prerequisite: Sociology 324 and 333, or consent of instructor. DENZIN.

429. **Seminar in the Sociology of Religion.** Detailed examination of research in the sociology of religion; the substantive character of religious groups and institutions as revealed by this research; significance of the research in the light of sociological theory and of other fields of sociological concern; the value of the current research methodology. 1 unit. Prerequisite: Sociology 400.

431. **Seminar on Social Deviance.** Systematic analysis of advanced theory and research on the social processes by which behavior becomes defined as deviant, the conditions promoting such behavior, and the career patterns of deviant persons, with particular attention to crime, delinquency, and mental disorder. 1 unit. Prerequisite: Sociology 331 and 333, or consent of instructor. BORDUA.

432. **Special Problems in Theory and Research on Deviant Behavior.** A seminar concerned with the critique of recent theory and research on selected problems in the study of delinquency, crime, and mental disorder, and the collaborative development of new theory and research designs. 1 unit. Prerequisite: Sociology 331 and 333, or consent of instructor.

435. **Field Instruction in Sociological Research on Treatment of Deviant Behavior** Problems of designing and conducting sociological research in agencies for the treatment of deviant behavior (prisons, training schools, police departments courts, mental clinics, mental hospitals); supervised training and practice in the functions of sociologists in these agencies. Application for admission to thi

course should be made early, preferably no later than the April prior to the summer session in which enrollment is desired, so that field placement arrangements can be made. S; 1 unit. Students may reregister in a subsequent summer for a second unit of credit, provided there is appreciable contrast in their two field locations. Prerequisite: Sociology 431, 333, and 424, or consent of instructor.

440. Political Sociology. An analysis of the impact of social cleavages and cohesion on the operation of political institutions and movements; the place of conflict and power in sociological theory; composition and behavior of power elites; participation in political associations; national and local power structure; social functions of electoral behavior; modern national and mass political movements. 1 unit. Prerequisite: A course in sociological theory or consent of instructor. WILEY.

444. Seminar in Public Opinion. Same as Communications 444. Development and theory of public opinion process in society; censorship, interest groups, and propaganda; mass media and public opinion. 1 unit. SIMON.

450. Problems of Soviet Society in Transition. This seminar examines certain major problems inherent in directed social change from an agricultural to an industrial system under a totalitarian regime of the Soviet type. Attention is focused on such areas as the different phases of the revolutionary process, inconsistencies between ideological premises and the demands of industrialism, the unanticipated consequences of social change, the simultaneous impact upon the social system of industrialism and totalitarianism, and implications of the Soviet experience for other countries. 1 unit. Prerequisite: Consent of instructor. VUCINICH.

456. Organizational Sciences, I. Same as Industrial Administration 410, Political Science 460, and Psychology 453. An introduction to the principal theories and important empirical research in various disciplines that study organizations. In addition to examination of the subject matter content of various disciplines, students critically examine the capacities and limitations of the various fields to make contributions to the study of organizations. 1 unit. Prerequisite: Enrollment as a major in organizational sciences in a cooperating program or approval of instructor.

457. Organizational Sciences, II. Same as Industrial Administration 411, Political Science 461, and Psychology 454. An introduction to the principal theories and important empirical research in various disciplines that study organizations. In addition to examination of the subject matter content of various disciplines, students critically examine the capacities and limitations of the various fields to make contributions to the study of organizations. 1 unit. Prerequisite: Sociology 456.

476. Urban Communities and Urbanization. Intensive study of special aspects of the urbanization process as it affects the life of communities in this and in other countries. 1 unit. KRONUS, LEWIS.

477. Seminar on Community Organization. Same as Rural Sociology 477. Theories relating to the community concept and the analysis of community organization; the process of community change as applied to societies in various parts of the world. 1 unit. Prerequisite: Sociology 275 or consent of instructor. FLIEGEL.

480. Sociological Theory and Method. This course is concerned with the strategy and tactics involved in the construction of specific substantive theories, considering such problems as concept formation, the use and development of models, criteria of good theory, and the role of theory in the development of sociological research. 1 unit.

482. Recent Developments in Sociology. Intensive study of selected topics based or contemporary works of major importance in the development of sociologica theory. 1 unit. Students may reregister for a total of two units credit.

485. The Sampling of Human Populations and Social Organizations. Same a Psychology 485. This course covers procedures for selecting samples from anc estimating population parameters for human populations and social organiza tions. The types of sample designs treated include simple random samples stratified, and cluster samples together with random number and systemati selection techniques. Emphasis is given to the study of various kinds o advanced sample designs for both area and institutional settings together witl the problems involved in the application of analytical statistics to complicate sampling procedures. Each student is required to participate in a field projec which involves the actual selection of a cluster sample from the local area. unit. Prerequisite: Sociology 387 or Economics 371, or consent of instructor.

486. Seminar on Experimental Sociology. The logic, design, and analysis of labora tory and field experiments, with special emphasis on the controlled investiga tion of social processes. 1 unit. Prerequisite: Sociology 385 or equivalent, o consent of instructor. SUMMERS.

487. Special Problems in Rural Sociology. Same as Rural Sociology 487. ½ or 1 unit Prerequisite: One unit of graduate credit in sociology; consent of instructor STAFF.

490. Individual Topics in Sociology. Supervised individual investigation or study c a topic not covered by regular courses. The topic selected by the student an the proposed plan of study must be approved by the adviser and the sta member who supervises the work. ½ to 2 units. STAFF.

492. Seminar on Models for Directed Change. Same as Social Work and Urba Planning 492. Construction and analysis of models for planned intervention a the personal, small group, and community levels. Construction of models a interpretations of behavioral science theory; extrapolating of hypotheses and c guides to intervention from the models. Reading from several disciplines a relevant. ½ or 1 unit. Prerequisite: Consent of instructor.

494. Multivariate Analysis in Psychology and Education. Same as Educationa Psychology and Psychology 494. The principal methods of descriptive statistic used in the analysis of multiple measurements, with emphasis on conventiona procedures of factor analysis; profile similarity models; discriminatory analysi multidimensional scaling. 1 unit. Prerequisite: Psychology 307 or Educationa Psychology 496; consent of instructor. TUCKER.

499. Thesis Research. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Social Systems and Institutions. An advanced discussion of general principl and concepts in sociology; among the topics discussed are culture, soci structure, socialization, primary groups, social stratification; their application problems in political sociology, industrialization, race relations, religion, ar delinquency; the bearing of these upon larger problems of social order ar social change. Designed for advanced undergraduate majors in sociology ar other social sciences and for graduate students in sociology without adequa preparation for graduate work. ½ or 1 unit. Prerequisite: Sociology 100 eight hours of social science, or consent of instructor. JOHNSON.

311. Sociology of Intellectual Life. A comparative sociological analysis of tl development of the intelligentsia in Europe and elsewhere. Central concer

include the institutional supports for intellectual work under various social and cultural conditions, the social origin and status of different types of intellectuals, the formation of distinct scientific traditions, and the relationships of these traditions to ideology, literature, and philosophy. This involves a critical scrutiny of the theoretical literature and methodology of the sociology of knowledge. ½ or 1 unit. Prerequisite: Sociology 100 or eight hours of social science, or consent of instructor. VUCINICH.

315. **Sociology of Education.** Same as History and Philosophy of Education 315. Objective comparative study of education as a social process in various cultures and historical periods, with main emphasis on present education in countries which share Western civilization. ½ or 1 unit. Prerequisite: Sociology 100 or 151. SUMMERS.

316. **Sociology of Adolescence.** Adolescence in modern societies; social class, ethnic and minority group membership, and other variables as in social development, search for identity, inter-generational conflict, academic and social failure, and juvenile delinquency; the socializing institutions of family, education, peer culture, politics, religion, welfare and social control, the work world and recreation and leisure. Emphasis on research. ½ or 1 unit. Prerequisite: Sociology 100 or 151.

317. **Sociology of Law.** A general treatment of the social origins and consequences of law and legal process. Special emphasis is placed on problems of legal change, on the structure and functioning of legal sanctions. Some attention is paid to law and law-like phenomena in other societies, including primitive societies, but the main focus is on American society. ½ or 1 unit. Prerequisite: Sociology 100. BORDUA, SIMON.

318. **Industry and Society.** Same as Labor and Industrial Relations 318. Introduction to the sociology of economic institutions; selected problems of technological change and industrialization; corporate organization and trade union structure; human relations in industry and the changing bases of managerial authority; changing consumption patterns and the redefinition of work and leisure. ½ or 1 unit. Prerequisite: Six hours of sociology including one of the following: Sociology 218, 223, 300, 322, 326, or consent of instructor. KARSH.

320. **Social Roles.** Contemporary role theory and related concepts such as social status and social interaction; age-sex, vocational, social class, and other role types; applications of this theory to the study of the socialization process and personal adjustment, and the analysis of critical group situations and social change. ½ or 1 unit. Prerequisite: Sociology 100 or 151. HULETT.

321. **Family, Kinship, and Crisis.** An analysis of family and kinship, with major concentration on the American family. Implications of the American kinship system for trends in courtship and mate selection, interaction among kin, and other areas of family life are investigated. Family crisis is used as a focus for analysis of family organization. ½ or 1 unit. Prerequisite: Sociology 185. FARBER.

322. **Sociology of Bureaucracy and Administrative Organization.** An analysis of major types of formal organizations from the viewpoint of generalized theories of organization and of substantive theories of bureaucratization and rationalization. Among the formal organizations studied are business enterprises and unions, educational and medical institutions, and non-voluntary organizations. The interrelations between bureaucracy, ideology, and social structure are particularly emphasized. ½ or 1 unit. Prerequisite: Nine hours of sociology including Sociology 300, or consent of instructor.

323. **The Small Social Group.** Same as Psychology 323. Theory, observation, and analysis of face-to-face social groups, such as friendships, cliques, clubs, commit-

tees, and laboratory and experimental groups. Deals with the characteristics, functions, and forms of interaction of small groups and covers recent theoretical and empirical developments in this field of sociology. ½ or 1 unit. Prerequisite: Sociology or Psychology 201. DENZIN.

324. **Penology.** Probation; parole; methods of institutional treatment. ½ or 1 unit. Prerequisite: Sociology 331.

326. **Social Mobility and Class Structure.** An advanced course in social stratification, concerned with patterns, causes, and consequences of social mobility and immobility. Includes the analysis of rising and falling classes in industrial and developing countries and the circulation of political, social, and economic elites, as well as institutional sources of individual mobility. ½ or 1 unit. Prerequisite: Sociology 223 or consent of instructor. TIEN.

328. **Sociology of Asian Religions.** A comparative study of the influences of religion on the societies of Asia, and vice versa, focused on the problems of social change and development. Concentration is upon the religions and social systems of Iran, India, Thailand, China, and Japan. ½ or 1 unit. Prerequisite: Sociology 229 or consent of instructor. JACOBS.

329. **Comparative Family Institutions.** Cross-cultural analysis of family institutions, with special reference to vital and demographic backgrounds and with stress on property, authority, and handling of deviance, and relationship to religion, economy, and polity. ½ or 1 unit. Prerequisite: Sociology 185. FARBER, LEWIS.

331. **Criminology.** Nature and extent of crime; past and present theories of crime causation; criminal behavior in American society and its relation to personal and cultural conditions. ½ or 1 unit. Prerequisite: Sociology 100 or 151.

332. **Research Methods in Social Psychology.** Same as Psychology 332. A lecture and laboratory course in the methods and techniques of social psychological research. Emphasis is given to methods for laboratory experiments on small groups. ½ or 1 unit. Prerequisite: Psychology or Sociology 201; Psychology 235 or Sociology 184 and 185.

333. **Sociology of Mental Health.** Mental health issues from social organizational, demographic, and social psychological perspectives; definitions of mental illness and treatment practices relating to changing social psychological and political ideologies. The patient and the mental hospital, and the potential role of the behavioral scientist as an agent of research, treatment, and change, with special reference to current mental health action programs, are investigated. 1 unit. Prerequisite: Sociology 100 or 151, and one course in abnormal psychology and one in social psychology, or consent of instructor.

340. **Social Movements.** Analysis of the factors in the formation and dynamics of social movements as collective behavior; patterns of growth, types of leaders, control mechanisms. ½ or 1 unit. Prerequisite: Sociology 100 or 151.

343. **Social Change in Developing Areas.** Description and analysis of recent social and cultural changes occurring in new nations and developing economies. Special attention is given to problems of traditional social structure undergoing modernization. Social factors in economic growth, caste and class, nation-building, urbanization and population composition, education, family and religion. ½ or 1 unit. Prerequisite: Sociology 100 or 151, or equivalent. JACOBS, KARSH.

344. **Public Opinion.** Same as Communications 344. Opinion changes and control; propaganda; interest groups and opinion; critical review of methods of measurement. ½ unit. Prerequisite: Sociology 100 or 151. SIMON.

350. **Soviet Social Institutions.** This course analyzes the major social institutions of Soviet society. Special attention is paid to the structural consequences of

Communist ideology, totalitarianism and industrialism, and to comparison with and implications for American society. The major areas covered are: population data and their sociological implications; history, values, and ideology; political institutions; economic institutions; social stratification and mobility; the nationalities; the family and education; communications and public opinion; socialized medicine. ½ or 1 unit. Prerequisite: Sociology 100 or consent of instructor. The prerequisite does not apply to majors and minors in Russian language and area studies. VUCINICH.

351. Advanced Social Psychology. Same as Communications and Psychology 351. An integrative treatment of individual behavior variables in relation to group variables. ½ or 1 unit. Prerequisite: Sociology or Psychology 201; Psychology 235 or Sociology 385, or a comparable statistics course. MCGRATH, STEINER.

352. Attitude Theory and Measurement. Same as Communications and Psychology 352. A comprehensive survey of psychological theories of attitude organization and change, and a theoretical and methodological analysis of the various techniques used to measure attitude. These theories and methods are evaluated with respect to empirical research in the area. ½ or 1 unit. Prerequisite: Sociology or Psychology 201; a course in statistics. FISHBEIN.

355. Chinese Society. Systematic treatment of China's social, cultural, and demographic heritage and of the impact of the west on an ancient civilization; the processes of planned and unplanned change in Chinese society. Topics include: peasant-land economy; the family; patterns of social stratification and social mobility; the persistence of traditional forms and the adoption and adaptation of new patterns. ½ or 1 unit. Prerequisite: Sociology 100, 151, and 152, Rural Sociology 117, or consent of instructor. TIEN.

359. The Social Psychology of Organization. Same as Psychology 359. Analysis of the interrelationships between social and psychological factors, on the one hand, and organizational structure and process, on the other; emphasis on sources, consequences, and modes of resolution of intra-individual, intra-organizational, and inter-organizational conflict. 1 unit. Prerequisite: Psychology 355 or Sociology 322. MCGRATH.

360. Sociology of the Professions. This course examines the nature, position, functions, and growing importance of the major professions in the contemporary industrial (or industrializing) society. Particularly close attention is paid to the relationship between the social system and the various professional "communities," recruitment, professional socialization, and bureaucratic vs. independent practice. ½ or 1 unit. Prerequisite: Sociology 100 or consent of instructor. TIEN.

369. Introduction to Human Ecology. Same as Anthropology, Geography, Health Education, Physiology, Psychology, Veterinary Medical Science, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations, and physiological, psychological, and sociological adjustments to environment, regulation of populations, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology; one year of anthropology, geography, geology, or sociology. TIEN, STAFF.

371. Comparative Social Institutions. This course examines, in a comparative perspective, some of the major institutional complexes of social systems, such as family and kinship structures, occupations, political institutions, and social stratification and mobility. Illustrative materials are drawn from a variety of societies, including primitive nonliterate societies and advanced industrial societies such as the United States, Germany, and the Soviet Union. ½ or 1 unit. Prerequisite: Sociology 100 or consent of instructor. JACOBS.

373. Latin-American Social Organization and Institutions. Analysis of contemporary institutional and social class structures in Latin-American communities and societies, and their relationship to certain religious and family patterns; the influence of the past and present trends in urbanization, ecological organization, and population growth upon Latin-American social systems and institutional organization. ½ or 1 unit. Prerequisite: Sociology 100 or 151, or consent of instructor. SOLAUN.

374. Problems in Human Ecology. Same as Anthropology, Geography, Health Education, Physiology, Psychology, and Veterinary Medical Science 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multidisciplinary studies of selected current problems. 1 unit. Prerequisite: Sociology, Anthropology, Geography, Health Education, Physiology, or Zoology 369. TIEN, STAFF.

385. Social Statistics, I. Deals intensively with descriptive statistics, probability, statistical inference, and significance testing by means of both parametric and nonparametric tests, and the various measures of association. 1 unit. Prerequisite: Sociology 185 or Mathematics 122 or 123, or consent of instructor.

386. Methods of Field Research. Same as Psychology 386. Instruction, training, and supervised practice in methods of field research as a basic tool of sociology. Major emphasis is placed on the role of the field researcher as participant, observer, and interviewer in various kinds of research settings, and on approaches to and applications of field data. Each student develops and executes a field research project dealing with some aspect of institutional, occupational, or general community activity and structure. ½ or 1 unit. Prerequisite: Sociology 184 and 185, or Psychology 235.

387. Social Statistics, II. Treats analysis of variance, analysis of covariance, multiple and partial correlations, and complicated sampling procedures. A semester problem is developed which emphasizes integration and application of various statistical techniques to sociological problems. ¾ or 1 unit. Prerequisite: Sociology 385.

SPANISH, ITALIAN, AND PORTUGUESE

The Department of Spanish, Italian, and Portuguese offers work leading to the Master of Arts and Doctor of Philosophy in Spanish, Italian, or Portuguese, and to a Master of Arts in the Teaching of Spanish. Fields of concentration are Spanish linguistics, Spanish literature, Latin-American literature, Italian literature, and Portuguese literature.

The departmental admission requirement is a grade-point average of at least 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis. Prerequisite for a graduate major is an undergraduate major in one Romance language or Latin, or consent of the department. Prerequisite for a minor is consent of the department.

Students doing graduate work for any advanced degree in Spanish must possess or acquire a practical command of the language. For the Doctor of Philosophy, some knowledge of Latin and Italian or Portuguese is required. The Latin requirement may be met by taking a minimum of one semester of Latin (two semesters in the specialization in Spanish linguistics) while in residence for the degree. Parallel training in one or more other languages or literatures, such as English, French, German, Greek, Italian, Latin, and Portuguese, is desirable.

Master of Arts.

(1) *Spanish or Spanish-American Literature.* Minimum requirements are: (a) any of the following not previously included in an undergraduate program: Spanish

05, 306, 307, 308, 309, 311, 314, 331 or 332, 351, 352; (b) Spanish 405; one of panish 415, 417, 419, 425; two of Spanish 421, 422, 423, 424, 426; one of Spanish 31, 432, 433, 434, 437, 438. The course program may be supplemented by courses rom the doctoral list or by courses totaling one or two units in a minor or one unit n each of two minors.

(2) *Spanish Linguistics.* Minimum requirements are: (a) any of the following ot previously included in an undergraduate program: Spanish 305, 306, 307, 308, 09, 311, 314, 331 or 332, 351, 352, 382; general linguistics: Linguistics 300, 302; and b) Spanish linguistics: Spanish 451 or 453; general linguistics: Linguistics 462; panish and Spanish-American literature: one each from two of the following roups: (i) Spanish, 415, 417, 419, 425; (ii) Spanish 421, 422, 423, 424, 426; (iii) panish 431, 432, 433, 434, 437, 438, 439. The course program may be supplemented y courses from the doctoral list.

(3) *The Teaching of Spanish.* Minimum requirements are: (a) up to three nits of any of the following not previously included in an undergraduate program: panish 305 or 306, 307 or 308, 311 or 314, and 331, 332, 351, 352, Linguistics 300; b) one of Spanish 415, 417, 419, 425; one of Spanish 421, 422, 423, 424, 426; one of panish 431, 432, 433, 434, 437, 438; (c) Educational Psychology 311, 312; (d) two f History and Philosophy of Education 303, 304, 305. The course program may be upplemented by courses from the doctoral list. See pages 38 and 39.

Doctor of Philosophy.

(1) *With Specialization in the Renaissance and Golden Age.* The minimum requirements, in addition to those for the master's degree, are: Spanish 411; three of Spanish 415, 417, 419, 425; one of Spanish 421, 422, 423, 424, 426; Spanish 453; two seminars.

(2) *With Specialization in the Nineteenth and Twentieth Centuries.* The minimum requirements, in addition to those for the master's degree, are: Spanish 411; one of Spanish 415, 417, 419, 425; three of Spanish 421, 422, 423, 424, 426; Spanish 453; two seminars.

(3) *With Specialization in Latin-American Literature.* The minimum requirements, in addition to those for the master's degree, are: Spanish 411; one of Spanish 415, 417, 419, 425; one of Spanish 421, 422, 423, 424, 426; Spanish 453; three of Spanish 431, 432, 433, 434, 437, 438, 439; two seminars; one of Portuguese 301, 303, 304, 407.

(4) *With Specialization in Spanish Linguistics.* The minimum requirements, in addition to those for the master's degree, are: (a) Spanish linguistics: Spanish 454 and 451 or 435; (b) Spanish and Spanish-American literature: Spanish 411, and one each from two of the following groups: (i) Spanish 425 or other (415, 417, 419); (ii) Spanish 426 or other (421, 422, 423, 424); (iii) Spanish 431 or 432 or other (433, 434, 437, 438); (c) two seminars: Spanish 452 and one in literature or language or general linguistics; (d) minor: general linguistics.

Students working toward the Doctor of Philosophy are admitted with provisional departmental status until their performance in graduate work is judged acceptable for full departmental status by the department's graduate committee.

The department should be consulted on the selection of minors. Minors available within the department are Spanish philology and linguistics; Italian; Portuguese; Spanish and Latin-American literature. Other minors are other languages and literatures, history, philosophy, anthropology, linguistics, Latin-American studies, and other closely allied subjects.

Candidates for an advanced degree in Italian or Portuguese should consult the department. Provisions are made to fit individual cases.

GRADUATE FACULTY

Professors: A. M. Pasquariello (Head of Department), J. H. D. Allen, J. S. Flores, H. R. Kahane, L. Leal, R. Montano, M. A. Morínigo, Angelina R. Pietrangeli, A. Porqueras-Mayo, W. H. Shoemaker.

Associate Professors: S. W. Baldwin, Jr., W. C. Blaylock, H. W. Cowes, M. H. Forster, R. E. Lott.
Assistant Professors: A. Aiex, D. R. Hershberg, T. C. Meehan, W. L. Meinhardt.

Spanish

COURSES FOR GRADUATES

400. Beginning Spanish for Graduate Students. Basic grammar and vocabulary; reading practice. No graduate credit.

401. Readings in Spanish for Graduate Students. Continuation of Spanish 400, with special readings in the critical literature of several disciplines. No graduate credit. Prerequisite: Spanish 400 or consent of instructor.

405. Spanish Bibliography. An introduction to bibliographical method and to the principal bibliographical resources for the study of Spanish and Latin-American literature. ½ unit. Blaylock.

411. Spanish Literature in the Middle Ages. 1 unit. Prerequisite: Spanish 309. Allen, Baldwin.

415. Renaissance and Baroque Prose in Spain. 1 unit. Prerequisite: Spanish 311 and 314, or equivalent. Allen, Porqueras-Mayo.

417. Renaissance and Baroque Drama in Spain. 1 unit. Prerequisite: Spanish 311 and 314, or equivalent. Flores, Morínigo.

418. Seminar in Renaissance and Baroque Literature. 1 unit. Prerequisite: Spanish 415 or 417. Morínigo, Porqueras-Mayo.

419. Cervantes. *Don Quixote* and representative minor works. 1 unit. Prerequisite: Spanish 311 and 314, or equivalent. Morínigo, Porqueras-Mayo.

421. Modern Spanish Novel and Essay. 1 unit. Cowes, Lott, Shoemaker.

422. Contemporary Spanish Novel and Essay. 1 unit. Cowes, Lott, Shoemaker.

423. Modern Spanish Drama. 1 unit. Lott, Pietrangeli, Shoemaker.

424. Contemporary Spanish Drama. 1 unit. Cowes, Lott, Shoemaker.

425. Renaissance and Baroque Poetry in Spain. 1 unit. Morínigo, Porqueras-Mayo.

426. Spanish Poetry of the Nineteenth and Twentieth Centuries. 1 unit. Pietrangeli.

431. Spanish-American Poetry: Middle America. 1 unit. Prerequisite: Spanish 307 and 308, or equivalent. Forster.

432. Spanish-American Poetry: South America. 1 unit. Prerequisite: Spanish 307 and 308, or equivalent. Forster.

433. Spanish-American Novel: Middle America. 1 unit. Prerequisite: Spanish 307 and 308, or equivalent. Leal, Meinhardt.

434. Spanish-American Novel: South America. 1 unit. Prerequisite: Spanish 307 and 308, or equivalent. Leal.

435. Seminar in Spanish-American Poetry. 1 unit. Prerequisite: Spanish 431 or 432. Forster.

436. Seminar in Spanish-American Novel. 1 unit. Prerequisite: Spanish 433 or 434. Leal.

437. Spanish-American Drama. 1 unit. Prerequisite: Spanish 307 or 308. Forster.

438. **Spanish-American Essay.** 1 unit. Prerequisite: Spanish 307 or 308. LEAL.

439. **The Spanish-American Short Story.** Intensive and analytical study of the principal *cuentistas* of Spanish America. 1 unit. Prerequisite: Spanish 307 or 308, or equivalent. LEAL.

442. **Seminar in Modern Spanish Literature.** Study of problems in the works of a major writer or group of writers of the eighteenth or nineteenth centuries. 1 unit. Prerequisite: Spanish 305; Spanish 421 or 423, or equivalent. LOTT.

443. **Seminar in Galdós.** Research work in novelistic criticism. Prerequisite: Spanish 305 or 306 and 311 or 314; Spanish 421 or 422. 1 unit. SHOEMAKER.

444. **Seminar in Spanish Realism and Naturalism.** Research work in nineteenth-century literary theory and practice in novel and drama. 1 unit. Prerequisite: Spanish 421 and 422. SHOEMAKER.

445. **Seminar in Twentieth-Century Spanish Literature.** 1 unit. Prerequisite: Spanish 421 or 422 or 423 or 424, or equivalent. LOTT, SHOEMAKER.

451. **Survey of Current Research in Spanish Linguistics.** Present-day methods of comparative, historical, and structural linguistics as applied to Spanish. 1 unit. KAHANE.

452. **Seminar in Spanish Linguistics.** Research work in Castilian and Latin-American linguistics. 1 unit. KAHANE, MORÍNIGO.

453. **History of the Spanish Language.** 1 unit. KAHANE, MORÍNIGO.

454. **Old Spanish.** 1 unit. BLAYLOCK, KAHANE, MORÍNIGO.

462. **Introduction to Romance Linguistics.** See Linguistics 462. ½ unit. Prerequisite: Four semesters of a Romance language or Latin, or equivalent. KAHANE.

471. **Teaching College Spanish.** A presentation of the problems of the teaching of Spanish and training in their solution, together with a study of procedures, methods, and laboratory techniques. No credit. FLORES.

491. **Special Topics in Spanish.** ½ or 1 unit. STAFF.

499. **Thesis Research.** 0 to 4 units. ALLEN, FORSTER, KAHANE, LEAL, LOTT, MORÍNIGO, PIETRANGELI, PORQUERAS-MAYO, SHOEMAKER.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

305. **Romanticism and Realism in Nineteenth-Century Spanish Literature.** A study of representative authors and genres of the nineteenth century, with particular emphasis on the romantic drama and the realistic novel. ½ unit. Prerequisite: Spanish 222 or equivalent. COWES, LOTT.

306. **The Generation of 1898.** A study of representative works of Baroja, Azorín, Unamuno, Maeztu, Valle Inclán, Benavente, A. Machado, and others. ½ unit. Prerequisite: Spanish 222 or equivalent. COWES, LOTT.

307. **Spanish-American Literature to 1888.** A study of the development of Spanish-American literature from the sixteenth century through the end of the Romantic period. ½ unit. Prerequisite: Spanish 222 or equivalent. FORSTER, LEAL, MEEHAN, MEINHARDT.

308. **Modernismo and Contemporary Spanish-American Poetry.** A study of Spanish-American poetry from 1888 to the present; some attention is given to *modernista* prose. ½ unit. Prerequisite: Spanish 222 or equivalent. FORSTER, LEAL, MEEHAN, MEINHARDT.

309. **Introduction to Medieval Spanish Literature.** Historical and cultural background for the Middle Ages; selected readings in medieval literature from the

Farchas to the *Corbacho*. ½ unit. Prerequisite: Spanish 305, 306, 307, or 308, or equivalent. BALDWIN.

311. Don Quixote and the Prose of the Golden Age. Introduction to *Don Quixote*, to its relationship to other selected masterpieces of the Golden Age, and to the main currents and forms of Golden Age prose. ½ unit. Prerequisite: Spanish 305, 306, 307, or 308, or equivalent. COWES, LEAL, PORQUERAS-MAYO.

314. Spanish Drama and Poetry of the Golden Age. ½ unit. Prerequisite: Spanish 305, 306, 307, or 308, or equivalent. FLORES, HERSHBERG, MORÍNIGO.

331. La Cultura Hispánica: España. ½ unit. Prerequisite: Spanish 222 or equivalent. FLORES, MORÍNIGO.

332. La Cultura Hispánica: Hispanoamérica. Required for teacher-training majors in Spanish. ½ unit. Prerequisite: Spanish 222 or equivalent. LEAL, MEINHARDT, MORÍNIGO.

351. Phonetics. ½ unit. Prerequisite: Spanish 222 or equivalent. ALLEN, BALDWIN, FLORES, KAHANE.

352. Syntax. ½ unit. Prerequisite: Spanish 222 or equivalent. BALDWIN, BLAYLOCK, FLORES, KAHANE, SHOEMAKER.

371. Spanish for Teachers. A consideration of language problems suggested by teaching experience. S; ½ unit. Prerequisite: Spanish 222 or equivalent. FLORES.

382. Language Laboratory Techniques. Same as French, German, and Russian 382. Instruction and practice in the techniques of making foreign-language tapes and integrating them with classroom activity; instruction in the problems of planning and operating a language laboratory. ½ unit. Prerequisite: Three years of a modern foreign language at the college level, or equivalent. MYERS.

Italian

COURSES FOR GRADUATES

400. Beginning Course for Graduate Students. Basic grammar and vocabulary; reading practice. No graduate credit.

403. Storia della letteratura italiana, I. Intellectual and literary movements in Italy from the thirteenth century to the Renaissance. 1 unit. MONTANO.

404. Storia della letteratura italiana, II. Intellectual and literary movements in Italy from the Baroque to the present. 1 unit. Prerequisite: Italian 403. MONTANO.

409. Storia della poesia di Dante. Philosophical and literary interpretation of Dante's works. 1 unit. Prerequisite: Italian 311 or 312 or 313 or equivalent. MONTANO.

411. Italian Literature in the Middle Ages: Petrarch and Boccaccio. 1 unit. PIETRANGELI.

412. Italian Literature in the Middle Ages: Petrarch and Boccaccio. 1 unit. PIETRANGELI.

415. Italian Literature of the Renaissance. 1 unit. PIETRANGELI.

416. Italian Literature of the Renaissance. 1 unit. PIETRANGELI.

422. Manzoni e il romanticismo europeo. Manzoni and the Romantic Movement. 1 unit. Prerequisite: Italian 321 and 322, or equivalent. MONTANO.

451. History of the Italian Language. 1 unit. KAHANE.

452. Seminar in Italian Linguistics. 1 unit. KAHANE.

462. **Introduction to Romance Linguistics.** See Linguistics 462. ½ unit. Prerequisite: Four semesters of a Romance language or Latin, or equivalent. KAHANE.

491. **Special Topics in Italian.** ½ or 1 unit.

499. **Thesis Research.** 0 to 4 units. KAHANE.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

Note: The prerequisite for 300-level courses is Italian 101 and 102. Italian 103 and 104 are desirable.

311. **Dante: La Divina Commedia.** ½ unit. PIETRANGELI.

312. **Dante: La Divina Commedia.** Continuation of Italian 311. ½ unit. PIETRANGELI.

313. **The Divine Comedy.** Same as Comparative Literature 313. An interpretation of Dante's *Divine Comedy* with special attention to its position in the medieval world. A knowledge of Italian is not required. ½ unit. KAHANE.

321. **Modern Italian Literature.** ½ unit. HERSHBERG, PIETRANGELI.

322. **Modern Italian Literature.** ½ unit. HERSHBERG, PIETRANGELI.

Portuguese

COURSES FOR GRADUATES

405. **Structure of Brazilian Portuguese: Phonology.** Phonetics and phonemics of modern Brazilian Portuguese. 1 unit. Prerequisite: Portuguese 104 or consent of instructor. ALLEN.

406. **Structure of Brazilian Portuguese: Morphology and Syntax.** Morphemics and syntax of modern Brazilian Portuguese. 1 unit. Prerequisite: Portuguese 405 or consent of instructor. ALLEN.

407. **Studies in Brazilian Literature.** Advanced study of literary movements, major writers, and intellectual and cultural ideas in Brazilian literature. The subject matter of the course varies each time the course is offered. 1 unit. Prerequisite: Portuguese 301 or consent of instructor. ALLEN.

408. **Studies in Portuguese Literature.** Advanced study of literary movements, major writers, and intellectual and cultural ideas in Portuguese literature. The subject matter of the course varies each time the course is offered. 1 unit. Prerequisite: Portuguese 302 or consent of instructor. FORSTER.

462. **Introduction to Romance Linguistics.** See Linguistics 462. ½ unit. Prerequisite: Four semesters of a Romance language or Latin, or equivalent. KAHANE.

491. **Special Topics in Portuguese.** ½ or 1 unit. STAFF.

499. **Thesis Research.** 0 to 4 units. ALLEN, FORSTER, KAHANE.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Introduction to Brazilian Literature.** ½ unit. Prerequisite: Portuguese 201 or consent of instructor. AIEX.

302. **Introduction to Portuguese Literature.** ½ unit. Prerequisite: Portuguese 201 or consent of instructor. AIEX.

303. **A Cultura Luso-Brasileira até 1822.** Designed to afford a broad understanding of the origins of Luso-Brazilian civilization and culture. ½ or 1 unit. Prerequisite: Portuguese 201 or 211 or consent of instructor. AIEX.

304. A Cultura Brasileira desde 1822. Designed to afford a broad understanding of contemporary Brazilian civilization and culture. ½ or 1 unit. Prerequisite: Portuguese 201 or 211 or consent of instructor. AIEX.

SPEECH

The Department of Speech offers courses leading to the Master of Arts, Master of Science, and Doctor of Philosophy.

Gradudate students interested in the theatre option for the Master of Arts and the Doctor of Philosophy are referred to course listings in the Department of Theatre, page 405, as well as applicable courses listed below.

The admission requirement, as to grade-point average, is at least 3.5 on a 5.0 scale.

For the degree of Master of Arts, students may concentrate in one of these areas: general speech, public address, theatre, oral interpretation, speech and hearing science. They may also select a special curriculum in the teaching of speech.

For the Master of Science, students may take a special curriculum in speech correction.

For the Doctor of Philosophy, students may exercise one of five options: rhetoric and public address; the theatre; speech and hearing science; experimental phonetics; oral interpretation.

In addition to meeting general regulations of the Graduate College, the Department of Speech specifies the requirements listed below.

Master of Arts. The entering student should present the equivalent of sixteen hours of undergraduate work in speech, including these courses or equivalents: voice and diction or fundamentals of speech, oral interpretation, an elementary course in phonetics, an elementary course in the theatre, and an advanced course in public speaking or discussion. A thesis may be required.

A final written examination is required of all candidates. In some cases an oral examination is also stipulated.

Master of Arts in the Teaching of Speech. Candidates for the Master of Arts who are interested in public school teaching should see pages 38 and 39 and also meet the following requirements:

(1) In the area of rhetoric and public address: Speech 311 and 312, one-half unit each; Speech 322 and 423, one unit each; and education, two units, including the following: History and Philosophy of Education 304 and 305, one unit, and Educational Psychology 311 and 312, one unit; electives, three units, one of which must be in speech.

(2) In the area of theatre: speech, four units, including Speech 352, 451, 452, and one of the following: Speech 361, 362, or 366; education, two units, including the following: History and Philosophy of Education 304 and 305, and Educational Psychology 311 and 312; electives, two units.

Master of Science in Speech Correction. The four-year curriculum preparatory to speech correction or its equivalent is a prerequisite for admission. Students who have not met all the requirements may register on approval of the adviser, the Coordinator of Teacher Education, and the Dean of the Graduate College.

Requirements include four units of speech selected from the following: Speech 475, 476, 481, 483, 484, 486, 488, 489, 491, 495; one unit from History and Philosophy of Education 304 and 305, and one unit from Educational Psychology 311 and 312; two units of electives. The electives may be in speech, in psychology, or, in exceptional cases, in other fields.

Doctor of Philosophy. Students are accepted as candidates for the doctor's degree who present either a well-rounded undergraduate education with at least

xteen hours of credit in speech or who hold a master's degree in speech or theatre rom an accredited institution.

RADUATE FACULTY

Professors: R. E. Nebergall (Head of Department), J. J. Bateman, Clara M. Behringer, A. J. Derbyshire, B. W. Hewitt, H. L. Mueller, R. Murphy, Marie H. Nichols, J. J. O'Neill, J. W. Scott, C. H. Shattuck.

Associate Professors: Mary H. Arbenz, K. W. Broadrick, K. Burns, M. E. Joseph, T. O. Sloan, E. W. Stark, B. R. Works, W. R. Zemlin.

Assistant Professors: R. D. Brooks, Ruth Anne Clark, R. G. Daniloff, R. L. Ince, Joanna L. Maclay, F. L. Nasca, Elaine P. Paden, Lois J. Sanders, T. H. Shriner, F. H. Silverman, R. K. Simpson, J. W. Wenzel.

OURSES FOR GRADUATES

402. **Seminar for Teachers of Speech.** Investigation of current principles, materials, and developments in the field of speech and of their relationship to the teacher. 1 unit. Burns.

411. **The Greek Tradition in Rheotric and Oratory.** The development of the Greek tradition in rhetorical theory, practice, criticism, and pedagogy from Homer to the Renaissance; analysis of the contributions of major figures and works to that tradition. 1 unit. Bateman.

412. **The Roman Tradition in Rhetoric and Oratory.** Development of the Roman tradition in rhetorical thought and practice from Cicero through the English Renaissance. 1 unit.

420. **Quantitative Methods in Rhetorical Analysis.** An introduction to the principles, procedures, and tools of research used in the quantitative analysis of the oral communication situation, including the experimental designs and statistical methods applicable to rhetorical analysis, and the identification, control, and measurement of rhetorical variables. Students participate in planning, executing, and reporting a limited experimental project investigating some oral communication variable. 1 unit. Offered in 1970–1971 and in alternate years. Prerequisite: Introductory course in statistics; consent of instructor.

423. **The Rhetoric of Aristotle.** Study of the *Rhetoric* in relation to other works of Aristotle. 1 unit.

430. **Contemporary Theories of Oral Communication.** Systematic study of speech-making and discussion as related to contemporary views of communication; examination of the theoretical literature and experimental evidence. 1 unit. Prerequisite: Consent of instructor.

436. **Seminar in Theories and Procedures of Discussion.** Investigation of the history, structure, and dynamics of dialectical forms of speech such as dialogue, panel, forum, debate, and parliamentary practices, with consideration of ethics, freedom of speech, and the forming of public opinion. 1 unit.

438. **Seminar in Rhetorical Theory.** Study of special topics in the history of rhetorical theory. 1 unit.

441. **Historical Background of Oral Interpretation.** Historical survey of British and American theories of interpretation. 1 unit. Sloan.

442. **Seminar in Oral Interpretation.** Investigation of basic problems in the history, nature, and function of oral interpretation. 1 unit. Prerequisite: Speech 441; consent of instructor. Sloan.

443. Seminar in the Oral Interpretation of Individual Literary Style. Examinatio of the literary style of an individual writer or selected writers, throug research, discussion, and oral readings; subject announced each semester. unit; may be repeated for a maximum of 2 units. Prerequisite: Speech 344.

451. Problems in Play Directing in the Educational Theatre. Same as Theatre 451 Study of the audience, play selection, the actor's abilities and needs, tryouts an casting, conduct of rehearsals and methods of directing, the dramatic clut contests and festivals. 1 unit. BEHRINGER.

452. Problems in Play Production in the Educational Theatre. Same as Theatre 45 Study of the school auditoria and stages, stage machinery and equipment an their use, lighting facilities and their use, organization of backstage crews, scen shifting and stage management, production problems of special types of plays. unit. BEHRINGER.

469. The Stage History of Classic English Plays. Same as Theatre and English 46 Analysis and reconstruction of past productions of classic plays, with specia reference to Shakespeare. 1 unit. Prerequisite: One year of work in dramati literature or theatre history; consent of instructor. SHATTUCK.

472. Psychoacoustics of Speech. Theory and principles of auditory perception c speech; survey of experimental and theoretical literature; laboratory demor stration and experimentation. 1 unit. Prerequisite: Speech 375, 376, 391, c consent of instructor. O'NEILL.

473. Seminar in Phonetics. Same as Linguistics 473. Advanced study in phoneti theory and noninstrumental phonetic investigation. 1 unit. Prerequisite: Cor sent of instructor.

475. Experimental Phonetics, I. Same as Linguistics 475. Theoretical consideratio of speech as motor behavior, with special reference to physiological investiga tions of normal respiration, phonation, and articulation. Survey of the exper mental literature. 1 unit. Prerequisite: Consent of instructor. ZEMLIN.

476. Experimental Phonetics, II. Same as Linguistics 476. Theoretical consideratio of speech as an acoustical phenomenon, with special reference to acoustic investigations of voice and speech sounds. Survey of the experimental liter ture. 1 unit. Prerequisite: Consent of instructor. ZEMLIN.

477. Measurement of Speech, I. Same as Linguistics 477. Principles and methods measuring speech action. Special action recorders and transducers; techniqu of analysis; problems of experimental design. Laboratory experimentation. unit. Prerequisite: Consent of instructor; credit or registration in Speech 47 ZEMLIN.

478. Measurement of Speech, II. Same as Linguistics 478. Principles and methods measuring the acoustical phenomena of speech. Oscillographic measurement vocal variables; special instruments and media for automation graphic recor ing; analysis of data; problems of experimental design. Laboratory experiment tion. 1 unit. Prerequisite: Consent of instructor; credit or registration in Spee 476. ZEMLIN.

481. Seminar in Neuropathologies of Speech and Language. Advanced study speech, vocal, and linguistics problems associated with cerebral palsy, aphasi and mental retardation. 1 unit. Prerequisite: Consent of instructor.

482. Seminar in Stuttering. Principles, theories, and methods of clinical manag ment of stuttering behavior in children and adults. 1 unit. Prerequisite: Spee 388.

483. Psychology of Speech and Hearing Disorders, I. Same as Psychology 483. survey of psychological techniques utilized in the clinical and experiment

study of speech and hearing disorders, with special reference to speech disorders. Review of research findings and development of experimental designs. 1 unit. Prerequisite: Consent of instructor. O'NEILL.

484. **Psychology of Speech and Hearing Disorders, II.** Same as Psychology 484. A survey of psychological techniques utilized in the clinical and experimental study of speech and hearing disorders, with special reference to hearing disorders. Review of research findings and development of experimental designs. 1 unit. Prerequisite: Consent of instructor. O'NEILL.

486. **Advanced Clinical Techniques in Speech and Hearing.** Advanced clinical techniques to be used in the management of speech and hearing disorders; semi-independent management of complex cases; participation in examination and analysis. ½ to 4 units. Prerequisite: Consent of instructor.

488. **Diagnostic Procedures in Pathologies of Speech and Language.** Study of diagnostic procedures used in the analysis of neuropathologies of speech and language and orofacial and laryngeal pathologies of speech. 1 unit. Prerequisite: Consent of instructor.

489. **Seminar in Orofacial and Laryngeal Pathologies of Speech.** Advanced study of speech and vocal problems associated with cleft palate, laryngeal dysfunctions and facial-maxillary disturbances. 1 unit. Prerequisite: Consent of instructor.

490. **Medical Aspects of Speech Disorders and Audiology.** Study of acute and chronic hearing and speech disorders traceable to disease of the ear and vocal mechanisms in relation to the techniques and philosophies utilized in a medically oriented environment. 1 unit. Prerequisite: Speech 385, 388, and 486. O'NEILL.

491. **Seminar in Hearing Disorders.** Principles and methods of clinical and classroom management of all types of hearing disorders. Survey of current literature and research. 1 unit. Offered in 1970-1971 and in alternate years. Prerequisite: Speech 391.

492. **Advanced Audiology.** Advanced study of rationale and development of principles associated with special techniques, procedures, and methods used in audiology. 1 unit. Prerequisite: Speech 395 and 397. STARK.

495. **Special Problems.** Individual investigation of special projects not included in theses. Open to master's candidates for one unit, to doctor's candidates for one or two units. 1 to 2 units. Prerequisite: Consent of head of department. STAFF.

499. **Thesis Research.** 0 to 4 units. BATEMAN, BEHRINGER, BROADRICK, BROOKS, BURNS, CLARK, HEWITT, INCE, MACLAY, MURPHY, NEBERGALL, NICHOLS, O'NEILL, SCOTT, SHATTUCK, SHRINER, SLOAN, STARK, WENZEL, ZEMLIN.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **General Phonetics.** Basic principles of phonetic study, including observation and representation of pronunciation; ear training; practice in transcription. ½ or 1 unit. PADEN.

307. **The Art of the Screen: Narration.** Same as Communications 307. Critical study of the adaptation and synthesis of principles of drama, literature, the graphic arts, and music in the evolution of the screen narrative. Lectures, discussions, and reports; viewing of selected films and television programs. ½ unit. Prerequisite: Training in critical approaches to literature, drama, art, or music; consent of instructor. MUELLER.

308. **The Art of the Screen: Exposition and Persuasion.** Same as Communications 308. Critical study of the application of the eclectic principles of the screen narrative to the transmission of information and the influencing of attitude,

opinion, and action. Lectures, discussions, and reports; viewing of selected films and television programs. ½ unit. Prerequisite: Speech 307 or consent of instructor. The prerequisite does not apply to students of library science who have obtained the necessary background through independent reading. MUELLER.

311. British Public Address. Study of representative British speakers and speeches from earliest times to the present. ½ or 1 unit. Prerequisite: Junior standing. MURPHY.

312. American Public Address. Study of representative American speeches from the sixteenth century to the present. ½ or 1 unit. BROADRICK.

313. Interpersonal Communication: Discussion and Interview. Advanced study of theory, research, techniques, and training methods in interviewing and group discussion; emphasis on empirical research findings concerning communication processes in face-to-face groups. ½ or 1 unit. Prerequisite: Consent of instructor.

321. Theories of Persuasion and Rhetorical Practice. A survey of theories of persuasion derived from rhetorical, philosophical, and psychological sources and their application to persuasive discourse. ½ or 1 unit. Prerequisite: Consent of instructor.

322. Modern Rhetorical Theory. Significant movements in the development of rhetorical theory in England, France, and America from 1700 to the present. ½ or 1 unit. NICHOLS.

323. Rhetorical Criticism. Methods of interpreting and judging persuasive discourse with emphasis on political speaking and writing. Lectures and practice in criticism. ½ or 1 unit. Prerequisite: Credit or registration in Speech 311, 312, or 322. NICHOLS.

325. Rhetorical Theory in the English Renaissance. Study of the principles of rhetoric in England, 1500-1700, including their application to selected literature and speeches of the period. ½ or 1 unit.

333. Style and Delivery. Study of verbal and nonverbal features of communicative and expressive utterance. ½ or 1 unit. Prerequisite: A sophomore course in composition (written or spoken) and junior standing, or consent of instructor.

342. Oral Interpretation of Poetry. Analysis and oral presentation of literature representative of various poetic forms. ½ or 1 unit. Prerequisite: Speech 141. BURNS, MACLAY, SLOAN.

344. Criticism of the Oral Interpretation of Literature. Examination of theories of aesthetics and practical criticism and their application to the criticism of specific examples of the oral performance of literature. ½ or 1 unit. Prerequisite: Speech 141, or graduate standing, or consent of instructor.

345. Contemporary Approaches to Oral Interpretation. Modern concepts underlying the relationship of interpretation to the reader's experience of literature; discussions, reports, oral interpretations of prose forms (including Chamber Theatre and Readers Theatre). ½ or 1 unit. Prerequisite: Speech 141 or consent of instructor. MACLAY, SLOAN.

346. Introduction to Folklore: History, Theory, Methods. Same as English, Comparative Literature, German, and Slavic Languages 394. An introduction to the study of folklore with emphasis on folk cultures in the Old and New World; a historical survey of the development of folklore study, an analysis of the methods and genres of folklore, and an introduction to field collecting and evaluation of archival materials. ¾ unit. Prerequisite: A reading knowledge of one modern foreign language is recommended.

352. **Introduction to Modern Theatre Art.** Same as Theatre 352. Origins and development of modern theatrical production; a critical examination of contemporary ideas and practices in theatre architecture, acting, directing, and staging. ½ or 1 unit. HEWITT.

361. **History of the European Theatre to the Renaissance.** Same as Theatre 361. The theatre and the theatre arts of ancient and of medieval Europe. ½ or 1 unit. SCOTT.

362. **History of the European Theatre from the Renaissance to 1900.** Same as Theatre 362. The European theatre and the theatre arts from 1576 to 1900, with special reference to the English theatre. ½ or 1 unit. SCOTT.

363. **Advanced Dramatic Writing.** Same as English 363, Radio and Television 363, and Theatre 380. Application of principles of dramatic form and structure to the more complex problems of playwriting. Practice in writing sustained dramatic forms. ½ or 1 unit; students may accumulate 2 units of credit. Prerequisite: Speech 263 or equivalent; consent of instructor.

366. **Development of the American Theatre.** Same as Theatre 366. The development of the theatre and of theatre arts in America from colonial times to the beginning of the twentieth century. ½ or 1 unit. HEWITT.

371. **History and Principles of Literary and Rhetorical Criticism: Aristotle to Sidney.** Same as English 371. ½ or 1 unit.

372. **History and Principles of Literary and Rhetorical Criticism: Sidney to the Present.** Same as English 372. ½ or 1 unit.

375. **Speech Science, I.** Same as Linguistics 375. Introduction to the anatomical and physiological characteristics of the normal speech and hearing mechanisms. ½ unit. Prerequisite: Speech 109 or 301, or consent of instructor. ZEMLIN.

376. **Speech Science, II.** Same as Linguistics 376. Consideration of the physiology of the speaking act, the acoustical characteristics of voice and speech sounds, and the hearing of speech. ½ unit. Prerequisite: Speech 375 or consent of instructor. ZEMLIN.

377. **The Bases of Speech and Hearing Science.** An introduction to the anatomical and physiological characteristics of the normal speech and hearing mechanisms, the acoustical characteristics of speech, and the hearing of speech. Not open to students with credit in Speech 375 or 376. ½ unit. Prerequisite: Speech 109 or equivalent; consent of instructor.

383. **Development of Spoken Language.** A study of the correlates of language development from the prelinguistic period to adulthood. ½ or 1 unit. Prerequisite: Consent of instructor.

385. **Speech Pathology, I.** Study of the causes, symptoms, and treatment of speech disorders, including articulatory, vocal, and rhythmical disorders; observation of clinical techniques is required. ½ unit. Prerequisite: Ten hours of speech including Speech 109 and credit or registration in Speech 375, or consent of instructor. SIMPSON.

386. **Basic Diagnostic and Therapeutic Principles of Speech Correction.** Instruction and practice in the administration and interpretation of diagnostic tests; discussion and demonstration of clinical approaches used with speech disorders. ½ unit. Prerequisite: Speech 385; credit or registration in Speech 388.

387. **Practicum in Speech Diagnosis and Therapy.** Observation, practice, and research in diagnosis and therapy of speech disorder. ½ unit. Prerequisite: Speech 386; a grade-point average of at least 3.5; consent of instructor.

388. **Speech Pathology, II.** Study of causes, symptoms, and treatment of speech disorders, including stuttering, cerebral palsy, aphasia, and cleft palate. ½ or 1 unit. Prerequisite: Speech 385. SIMPSON.

390. **Communication Disorders in Children: Habilitation and Rehabilitation.** Principles of differential diagnosis, therapeutic diagnosis, clinical and classroom habilitation and rehabilitation of children with communicative disorders etiologically associated with neurological impairment, emotional disturbance, environmental deprivation, bilingualism, and mental retardation. ½ or 1 unit. Prerequisite: Speech 383; consent of instructor.

391. **Introduction to Hearing Disorders.** Analysis of symptoms and causes of hearing losses; effects of hearing loss upon oral communication, education, and psychological adjustment; principles of retraining the hard-of-hearing. ½ unit. Prerequisite: Speech 375 or consent of instructor. STARK.

393. **Aural Rehabilitation.** Principles and methods of clinical and classroom retraining of the hard-of-hearing, including lip reading, auditory training, speech correction and conservation, counseling. Required in curriculum of teacher training in speech correction. ½ or 1 unit. Prerequisite: Speech 391; a grade-point average of at least 3.5; consent of instructor. NASCA.

394. **Hearing Conservation.** A survey of auditory screening methods, educational and protective measures, and follow-up procedures utilized in public health, public school, and college, military, and industrial settings. ½ or 1 unit. Prerequisite: Speech 391 and 395.

395. **Audiometry.** Principles and application of basic audiometry. ½ or 1 unit. Prerequisite: Speech 391 or consent of instructor.

396. **Diagnosis of Hearing Impairments in Infants and Young Children.** Symptoms and causes of hearing impairment in young children; practice in procedures used for the measurement of residual hearing; selection and use of hearing aids. ½ or 1 unit. Prerequisite: Speech 391 and 395, or consent of instructor.

397. **Measurement of Auditory Perception.** Principles and methods of clinical assessment of auditory perception. Intensive study of measurement techniques for speech perception; applications with clinical clients; survey of current literature and research. ½ or 1 unit. Offered in 1969-1970 and in alternate years. Prerequisite: Speech 391 and 395. O'NEILL.

398. **Practicum in Audiology.** Observation, practice, and research in diagnosis and rehabilitation of auditory disorders. ½ unit. Prerequisite: Speech 393. STARK.

399. **Design and Analysis of Experiments in Speech and Hearing Science.** An introduction to experimental designs and methods of statistical analysis in speech and hearing research. ½ or 1 unit. Prerequisite: Graduate standing or consent of instructor.

THEATRE

The Department of Theatre offers the Master of Arts. Students interested in a doctoral program should meet the requirements for the Ph.D. in Speech with a theatre option. For further information, see descriptive material given under the Department of Speech, page 398.

Master of Arts. Admission requirements are a grade-point average of at least 3.5 and (1) an undergraduate major in theatre, which includes at least nine hours in dramatic literature either as part of the major or in addition to the major, or (2) any undergraduate major, which includes at least nine hours of basic courses in theatre (acting, direction, production) and seven hours in speech or dramatic literature.

Candidates who are deficient in one or more of the above requirements may be admitted provisionally to the program.

Degree requirements are a minimum of six units, including two units in history and theory and two in applied theatre; and a final written examination. A candidate may offer a research thesis for no more than two of the eight units required by the Graduate College.

Doctor of Philosophy in Speech with a Theatre Option. Admission requirements are a grade-point average of at least 4.0 in the last four semesters of undergraduate and/or graduate work and (1) an undergraduate major in theatre which includes at least nine hours in dramatic literature, either as part of the major or in addition to the major, or (2) an undergraduate major in a related field, such as speech, English, dance, art, radio and television, with at least nine hours of course work in dramatic literature; or a Master of Fine Arts degree in theatre or a Master of Arts degree in theatre, or the equivalent, with a thesis or other evidence of research ability.

Degree requirements are a minimum of ten units in theatre courses, exclusive of thesis research, and a minor of four units in one or more related areas.

GRADUATE FACULTY

Professors: B. HEWITT (Chairman of Department), CLARA M. BEHRINGER, J. W. SCOTT, C. H. SHATTUCK.
Associate Professors: MARY H. ARBENZ, B. R. WORKS.

COURSES FOR GRADUATES

400. Seminar in Dramatic Form and Structure. Studies in the relationship of dramatic form and structure to the contemporary production of historical and modern plays. 1 unit. Prerequisite: Theatre 361 and 362, or equivalent; consent of instructor.

451. Problems in Play Directing in the Educational Theatre. Same as Speech 451. Study of the audience, play selection, the actor's abilities and needs, tryouts and casting, conduct of rehearsals and methods of directing, the dramatic club, contests and festivals. 1 unit. BEHRINGER.

452. Problems in Play Production in the Educational Theatre. Same as Speech 452. Study of the school auditoria and stages, stage machinery and equipment and their use, lighting facilities and their use, organization of backstage crews, scene shifting and stage management, production problems of special types of plays. 1 unit. BEHRINGER.

461. Advanced Theatre Techniques. Individual development of advanced techniques of acting and staging through supervised participation in public productions. ½ or 1 unit. Prerequisite: At least one semester of graduate study in the area of theatre; consent of head of department and of instructor.

463. Seminar in the History of Acting. Studies in the history and theory of the art of acting. 1 unit. Students may accumulate maximum credit of two units. Offered in 1969-1970 and in alternate years. ARBENZ.

465. Seminar in Theatre Art. Studies in the aesthetics of the theatre. 1 unit. HEWITT.

466. The American Theatre Since 1900. Major developments in acting, production, playwriting, organization, and operation. 1 unit. BEHRINGER.

468. Seminar in Theatre History. Studies in the history of the theatre. 1 unit. HEWITT.

469. The Stage History of Classic English Plays. Same as Speech and English 469. Analysis and reconstruction of past productions of classic plays, with special reference to Shakespeare. 1 unit. Prerequisite: One year of work in dramatic literature or theatre history; consent of instructor. SHATTUCK.

491. Special Problems. Individual research in selected topics by arrangement with the instructor. ½ to 2 units.

499. Thesis Research. 0 to 2 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Practicum, II. Advanced laboratory in acting, directing, playwriting, theatre management, and the design, construction, and handling of scenery, lighting, sound, properties, costumes, and makeup for public performance. May be repeated three semesters. ½ unit. Prerequisite: For non-theatre majors, consent of instructor.

351. Styles of Acting for Period Plays. Study and practice of traditional styles of acting in dramas by important playwrights representing major theatrical eras such as Sophocles, Aristophanes, Shakespeare, Racine, Moliere, Congreve, Wilde. Lectures, demonstrations, exercises, performance. ½ unit. Prerequisite: Theatre 261 or consent of instructor. ARBENZ.

352. Introduction to Modern Theatre Art. Same as Speech 352. Origins and development of modern theatrical production; a critical examination of contemporary ideas and practices in theatre architecture, acting, directing, and staging. ½ or 1 unit. AHART.

353. Creative Dramatics for Children. A study of the subject matter and techniques of creative dramatics for children, with laboratory application. ½ or 1 unit. Prerequisite: Consent of instructor. TYMCHYSHYN.

354. Theatre for the Child Audience. A study of the history, objectives, and techniques of play production for the child audience, with laboratory application. ½ or 1 unit. Prerequisite: Consent of instructor. TYMCHYSHYN.

361. History of the European Theatre to the Renaissance. Same as Speech 361. The theatre and the theatre arts of ancient and of medieval Europe. ½ or 1 unit. SCOTT.

362. History of the European Theatre from the Renaissance to 1900. Same as Speech 362. The European theatre and the theatre arts from 1576 to 1900, with special reference to the English theatre. ½ or 1 unit. SCOTT.

366. Development of the American Theatre. Same as Speech 366. The development of the theatre and of theatre arts in America from colonial times to the beginning of the twentieth century. ½ or 1 unit. ARBENZ.

368. History of Theatre Costume. A survey of the history of costumes worn on the stage from the classical Greek period to the present. ½ or 1 unit. Prerequisite: Theatre 120 and 281, or consent of instructor.

370. Stage Scenery Design. Theory and practice of designing stage scenery. ½ or 1 unit. Prerequisite: Theatre 120 or Speech 157 and two of the following: Theatre 255, 352, 361, 362, or consent of instructor. WORKS.

380. Advanced Dramatic Writing. Same as Speech, English, and Radio and Television 363. Application of principles of dramatic form and structure to the more complex problems of playwriting. Practice in writing sustained dramatic forms. ½ or 1 unit; students may accumulate 2 units of credit. Prerequisite: Theatre 280; consent of instructor.

381. Directing, II. Production problems and techniques of movement and business for non-proscenium staging areas; direction of appropriate scenes for class presentation; study of production practices for the musical play. ½ unit. Prerequisite: Theatre 281.

THEORETICAL AND APPLIED MECHANICS

The Department of Theoretical and Applied Mechanics offers work leading to the Master of Science and Doctor of Philsophy.

Graduate students electing theoretical and applied mechanics as their major usually have a bachelor's degree in engineering. Students having a bachelor's degree with a major in mathematics, computer science, engineering physics, engineering science, and similar areas, who have had the equivalent of the undergraduate courses usually required for the bachelor's degree in engineering, however, may also elect to major in theoretical and applied mechanics. Admission requires a 4.0 grade-point average for the last sixty semester hours of work completed in terms of a five-point scale (A = 5.0). Applications of students with grade-point averages below 4.0 but above 3.74 are considered on an individual basis.

Candidates for the Doctor of Philosophy are required to take, in addition to the thesis, at least one-half unit from each of the following areas in the department: (1) applied mathematics, (2) dynamics and vibrations, (3) fluid mechanics, (4) mechanics of solids, (5) materials engineering. A student majoring in one of these areas may elect a second minor in one of the other areas, providing the first minor is outside the department.

The course prerequisites for a minor in theoretical and applied mechanics are, in general, the same as for a major, but with certain modifications depending on the student's interests and objectives. The course requirement for a minor for the Master of Science is one unit; for the Doctor of Philosophy, the requirement for a sole minor is four units and for a second minor, two units.

For the Doctor of Philosophy degree, proficiency in reading one foreign language is required. Passing the Educational Testing Service examination in German or French is accepted.

The department has strong programs in the five areas noted below. There are several disciplines, such as biomechanics, that cut across all five areas.

Dynamics. An understanding of the response of a mechanical system to a dynamic environment is basic to the analysis and design of many mechanical systems. Major areas of research include kinematics and kinetics. Research in kinetics usually involves deformable bodies, fluids, and materials behavior. Irregular or random type loading on deformable bodies has been the subject of much research. A statistical approach to the latter problem has made it possible to predict the probability of finding response of a system within a certain range.

Fluid Mechanics. This study concentrates on the fundamental phases of fluid behavior with particular regard to the manner in which fluids flow in technological applications. Both gas and liquid motions are considered. Recent studies have centered on turbulence and boundary layer theory and into laminar viscous flows of physiological systems, including simulation of cerebral circulation problems. Body flow is being studied in the low Reynolds number range, where fluid inertia effects are appreciable and such factors as wave reflections, head loss, and flow stability at conduit branches are important.

Mechanics of Deformable Bodies. This study concerns load carrying members or structures that are subjected to various types of loads and to various temperature environments. Methods of analysis follow two distinct phases, experimental or analytical, although the two phases often complement each other. Some experimental research involves two- and three-dimensional photoelasticity, reflective photoelas-

tic coating, brittle coating, foil and semiconductor strain gages, Moire method, holographic methods, and displacement transducers. The analytical phase consists of mathematical theories such as elasticity, elastic stability, plasticity, and viscoelasticity.

Behavior of Engineering Materials. Emphasis is placed both on an understanding of the fundamental factors that control deformation and fracture of materials. Research encompasses studies of metals and nonmetals (including concrete, plastics, glass, and composites) and includes the inherent influence of environment on the mechanical behavior of materials in current and future engineering applications. Research is characterized by study of "analysis models" the results of which are combined with the data from a limited number of experiments to predict the performance of a structural or machine part in service.

Major in Applied Mathematics. Graduate students in theoretical and applied mechanics also may major in applied mathematics. See mathematics (applied), page 307. The student takes at least one-half his work in one or more of the following areas: dynamics, fluid mechanics, material engineering, or mechanics of deformable bodies.

GRADUATE FACULTY

Professors: T. J. Dolan (Head of Department), A. P. Boresi, C. E. Bowman, M. E. Clark, H. T. Corten, G. A. Costello, R. A. Eubanks, P. G. Jones, C. E. Kesler, H. L. Langhaar, R. E. Miller, J. Morrow, J. M. Robertson, O. M. Sidebottom, G. M. Sinclair, J. O. Smith, M. C. Stippes, C. E. Taylor, H. R. Wetenkamp, W. J. Worley.
Associate Professors: A. C. Bianchini, D. E. Carlson, J. W. Murdock.
Assistant Professors: F. Bauling, R. S. Jensen, L. K. Shirely, J. C. Wiley.

COURSES FOR GRADUATES

400. Seminar in Engineering Mechanics. There are many special topics in the field of mechanics such as fracture of metals, creep of materials, etc., in mechanics of solids; fluid flow problems such as the nature of turbulence, boundary layer theory, nature and effects of roughness of boundary, effects of free surface; dynamics problems such as vibration of beams with moving loads, the gyroscope, etc. Certain other topics, such as biomechanics, cut across all areas of mechanics. Such special topics as these are covered in this course. Each semester one or more of these topics is selected and announced as the area to be covered in this course during that semester. 1/4 unit. Staff.

412. Vibration Analysis. Continuation of Theoretical and Applied Mechanics 311. Specific topics are systems of several degrees of freedom; applications of generalized coordinates and Lagrange's equations; boundary value problems in vibration of elastic bodies, including strings, rods, and beams; Stodola's methods; iteration process and matrix procedure; vibrations in reciprocating machines, airplane structures and propellers; impact and transient vibrations; self-excited vibration; stability; nonlinear systems. 1 unit. Prerequisite: Theoretical and Applied Mechanics 311 or equivalent. Jones.

416. Energy Principles in Engineering Mechanics. Designed to introduce the student to the variational principles of mechanics and their applications to engineering problems. The derivation, interpretation, and applications of the principle of virtual displacements, the principle of minimum potential energy, the principle of complementary energy. Castigliano's theorem, Hamilton's principle, and Lagrange's equations of motion constitute the main part of the course. Variational methods of approximation are treated briefly. The material in-

cludes numerous illustrative applications to stress analysis of statically determinate and statically indeterminate frames, problems of elastic stability, the theories of rings and curved beams, the theory of elastic plates, vibrations of structures, and wave motions. 1 unit. Prerequisite: Theoretical and Applied Mechanics 451. BORESI, LANGHAAR, TAYLOR.

424. **Properties of Engineering Materials.** Structure of metals and behavior of materials under various conditions of loading and use, including static, creep, fatigue, and impact; effects of high and low temperature, strain rate, state of stress, and internal structure; criteria of failure; relation of mechanical properties to behavior; significance of mechanical properties; tests and interpretation of test data; material specifications. ½ or 1 unit. CORTEN, SINCLAIR.

425. **Mechanics of Inelastic Bodies.** The course presents methods of obtaining relations between loads, deformations, stresses, and strains in various members that are stressed beyond the elastic range. Most applications consider both time-independent and time-dependent (creep) inelastic deformations. Some specific topics are straight and curved beams, columns and beam-columns, fully plastic analysis of statically indeterminate members and structures, torsion of circular and noncircular bars, and torsion-tension of bars of circular cross-section. ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 321. SIDEBOTTOM, SMITH.

426. **Stress and Deformation in Engineering Components.** Continuation of Theoretical and Applied Mechanics 321: energy principles, forces and moments in plane and three-dimensional indeterminate members; beams on elastic support; flat plates, thick-walled cylinders, rotating disks, including temperature stresses; contact stresses and deflections; values and significance of stress concentrations. ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 321 or equivalent. SIDEBOTTOM, SMITH.

427. **Theories of Mechanical Properties and Behavior of Plain Concrete.** Theories used in the design of concrete and the factors affecting the properties and behavior of the material and of the test piece. Behavior of plain concrete under different types of environment and of loading, such as long time, repeated, and tri-axial, are emphasized. The studies involve critical reviews of experimental and analytical investigations. ½ to 1 unit. Prerequisite: Bachelor Science in engineering. KESLER.

428. **Analysis of Nonlinear Systems.** Same as Electrical Engineering 428. Singular points and stability considerations are treated. Graphical and analytical methods including the perturbation method, variation of parameters, Galerkin's method, and the Ritz method for solving nonlinear differential equations are considered. 1 unit. Prerequisite: Mathematics 341; consent of instructor. WORLEY.

431. **Theory of Ideal Fluid Flow.** Together with Theoretical and Applied Mechanics 432, topics in advanced fluid mechanics are covered that are the basis of many modern developments. Ideal fluid theory is concerned with an incompressible fluid of negligible viscosity. The differential equations of motions are derived and the several methods of obtaining flow solutions are presented: the obtaining of velocity potentials and stream functions by superposition of the effects of source, doublets, and vortices, and by the methods of conformal mapping. Relations for finding the resultant forces and moments on bodies are derived and applied to bodies such as lifting surfaces. Other topics covered include the theory and application of free streamline flows, vortex motions, and surface wave theory. 1 unit. Prerequisite: An elementary course in fluid flow; a course in advanced calculus. ROBERTSON, SHIRELY.

432. **Theory of Flow of Viscous Fluids.** Although a logical continuation of Theoretical and Applied Mechanics 431, this course need not be taken sequentially.

Concerned with the theoretical development, analysis, and solution of incompressible viscous fluid flow problems. Starting with the stress relations occurring in viscous fluids, the differential equations of motion are derived and direct and approximate solutions for laminar flows are developed. Boundary-layer theory is presented and the occurrence of turbulence and its characterization introduced. The basic equations for analyzing turbulent flows are introduced and approximate solution for flows in boundary-layers with and without pressure gradients (and separation) pipes and jets are presented. Includes consideration of experimental observation and application to technological problems. 1 unit. Prerequisite: An elementary course in fluid flow; a course in differential equations. ROBERTSON, SHIRELY.

438. **Turbulence.** Starting with the statistical modes of characterizing turbulence, discussion covers statistical theory, energy considerations, and nature of turbulence in typical flows. Laboratory experiments are used to illustrate hot wire technique of turbulence measurements and the structure of turbulence. 1 unit. Prerequisite: Theoretical and Applied Mechanics 432 or equivalent. ROBERTSON.

441. **Applied Analysis in Engineering.** A course to provide training in applications of mathematics to engineering problems. Most of the illustrations are taken from engineering mechanics. 1 unit. Prerequisite: Mathematics 143; Mathematics 343 and 345 are recommended. COSTELLO, LANGHAAR, MILLER.

442. **Applied Analysis in Engineering.** Continuation of Theoretical and Applied Mechanics 441. 1 unit. Prerequisite: Mathematics 143; Mathematics 343 and 345 are recommended. COSTELLO, LANGHAAR, MILLER.

451. **Theory of Elasticity with Application to Engineering Problems.** A study of the mechanics of elastic deformable bodies, based on the fundamental concepts of equilibrium, geometry of strain, and properties of materials. Relations between stresses, strains, and displacements are studied in detail with special consideration given to their significance in engineering problems. 1 unit. Prerequisite: Theoretical and Applied Mechanics 221; Mathematics 343; Mathematics 341 or equivalent. BORESI, EUBANKS, LANGHAAR, MILLER, TAYLOR.

452. **Theory of Elasticity with Application to Engineering Problems.** Continuation of Theoretical and Applied Mechanics 451. 1 unit. Prerequisite: Theoretical and Applied Mechanics 451. BORESI, LANGHAAR, STIPPES.

454. **Theory of Shells.** A course designed to provide the theoretical basis of stress analysis of shell-type structures, such as ships, submarines, monocoque aircraft structures, concrete roofs and domes, pressure vessels, and containers for liquids. The material includes the differential geometry of shell theory, equilibrium equations, momentless theory of shells, strains in shells, statically indeterminate problems of shells, energy formulations, and stability of shells. 1 unit. Prerequisite: Theoretical and Applied Mechanics 451. BORESI, LANGHAAR.

457. **Classical Elastostatics.** A modern unified treatment of the concepts and techniques developed in the course of investigation of the Cauchy-Navier equations. Emphasis on the interpretation and motivation of ideas and their interrelation for the solution of three-dimensional problems. Topics include the classical boundary-value problems, existence and uniqueness theorems, stress functions and displacement potentials, singular states of stress, extension of Green's method to the equations of elasticity, method of series, and approximation techniques. Course represents a preparation for (1) students interested in the current state of knowledge in classical elasticity, and (2) students intending to do doctoral dissertations in classical elasticity. 1 unit. Prerequisite: Theoretical and Applied Mechanics 451 or equivalent; consent of instructor. STIPPES.

458. **Wave Motion in Continuous Media.** An analysis of the dynamics of deformable bodies with a major emphasis on elastic media. Introduces the terminology

associated with and the methods of treating such problems. Includes a general discussion of the motion of strings, bars, shafts, plates, and other bodies when subjected to load. Detailed examination of approximations involved is made and their engineering significance is discussed. 1 unit. Prerequisite: Theoretical and Applied Mechanics 311, 314, 451; Mathematics 341, 342, 343, or equivalent. EUBANKS, STIPPES.

460. **Continuum Mechanics, II.** Continuation of Theoretical and Applied Mechanics 360. Viscous fluids (without memory) and elastic bodies as examples of simple materials, general principles of continuum thermodynamics, thermodynamics of elastic bodies, selected topics in modern continuum mechanics. 1 unit. Prerequisite: Theoretical and Applied Mechanics 360.

462. **Theory of Plasticity.** The physical and mathematical formulation of the mechanics of inelastically deformed bodies, plastic stress-strain laws, and their association with yield and loading function. Deals primarily with members subjected to bi-axial and tri-axial stress conditions. Specific topics include applications to flexure and torsion of prismatic members; expansion of thick-walled cylinders and spherical shells; introduction to problems in plane plastic flow and variational plasticity. ½ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 451 or equivalent. SIDEBOTTOM.

464. **Theory of Buckling.** The pertinent information and theoretical background required for the prediction of failure by buckling of structures such as airplanes, ships, bridge trusses, fabricated towers and shells; practical illustrations. Specific topics are elastic columns with various end restraints; buckling of frameworks, arches, rings, and plates; inelastic buckling of columns and plates; lateral buckling of beams; energy theory; Ritz procedure; Euler's equation of the calculus of variations. ½ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 416 and 451. COSTELLO, LANGHAAR.

467. **Thermomechanics of Nuclear Reactor Systems.** Same as Nuclear Engineering 467. Origin of thermomechanics problems in nuclear reactor systems; heat generation and transfer in nuclear power systems; thermal stress in nuclear reactor systems; dynamical theory including effects of thermal-shock and thermal stress-wave propagation; current thermo-mechanics problems in nuclear reactor design. Term paper required. 1 unit. Prerequisite: Nuclear Engineering 401 or consent of instructor. BORESI.

472. **Advanced Photoelasticity.** Theoretical and practical aspects of modern photoelasticity. Topics include: three-dimensional photoelasticity, birefringent coatings, dynamic photoelasticity, photoplasticity, photoviscoelasticity, and photothermoelasticity. 1 unit. Prerequisite: Theoretical and Applied Mechanics 326, 451, or consent of instructor. TAYLOR.

493. **Advanced Independent Study (Special Problems).** Analytical or experimental studies in one or more phases of theoretical and applied mechanics, including mechanics of materials, theory of elasticity, theory of plasticity, properties of materials, mechanical vibrations, hydraulics and fluid mechanics, fatigue of metals, etc. ½ to 2 units. STAFF.

499. **Thesis Research.** 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. **Mechanical Vibrations.** Kinematics of vibratory motion; comprehensive study of motion having single degree of freedom; critical speeds of shafts; vibration of systems with several degrees of freedom. Applications to engineering problems. Credit is not given for both Civil Engineering 374 and Theoretical and Applied Mechanics 311. ½ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 154, or 156 or 211 or 212 and 221.

314. Advanced Dynamics for Engineers. Three-dimensional kinematics of a rigid body, general dynamics of a rigid body, moments and products of inertia, kinetic energy, rotation of a rigid body about a fixed axis and about a fixed point, Euler equations of motion, gyroscopic theory; introduction to Lagrange equations; engineering applications. 1 unit. Prerequisite: Theoretical and Applied Mechanics 211 or equivalent; Mathematics 341 or 345.

315. Advanced Dynamics with Applications to Engineering Problems. General advanced methods of dynamics are discussed. Some emphasis is placed on the behavior of special components of guidance and control systems. Associated engineering problems are treated. Topics: Lagrange equations and Hamiltonian canonical equations; Hamiltonian methods; theory of vibrations; special theory of relativity, gyroscopic compass; gyroscopic stabilizer; modern gyroscopes; astronomical applications. 1 unit. Prerequisite: Theoretical and Applied Mechanics 314 or equivalent.

321. Advanced Mechanics of Deformable Bodies. Basic concepts of mechanics of deformable bodies and brief review of elementary topics; theory of stress and strain at a point; theories of failure, including failure by fracture; unsymmetrical bending; curved beams; torsion of noncircular sections; energy principles; Castigliano's theorem. ½ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 221 and 223 or 224.

324. Flow and Fracture of Structural Metals. Fundamental concepts of strength of crystalline engineering materials at atomic, single crystal, and polycrystalline levels of association in relation to engineering mechanisms of failure; functional relationship between material variables, state of stress, strain, time, temperature, and failure of engineering components by creep, stress rupture, fatigue, and brittle fracture. ¾ unit. Prerequisite: Theoretical and Applied Mechanics 221 and 224, or consent of instructor.

326. Experimental Stress Analysis. Measurement of stresses or deformations that are of significance in the engineering design of load-resisting members; use of optical, electrical, and mechanical instrumentation, models, analogies, brittle coatings, electrical resistance gages, photoelasticity, etc. ½ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 150, 211, 212, 221, and 223 or 224. Theoretical and Applied Mechanics 321 is desirable.

334. Fluid Mechanics and Advanced Hydraulics. A study of the basic properties of fluids in general, particularly those that influence the flow of fluids in pipes and open channels, viscosimetry, dimensional analysis, effect of boundary conditions, cavitation, water tunnel, hydraulic jump, water hammer, pumps, turbines. Some laboratory work. ½ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 235.

335. Dynamics of Fluids. An intermediate course in the mechanics of fluids introducing analytical methods of solution for ideal and real fluids. Potential flow theory, theoretical approaches to viscous flows including boundary-layer theory, and the analysis of compressible flows are indicated. ¾ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 235.

346. Dimensional Analysis and Theory of Models. The nature and use of dimensions, systematic calculation of dimensionless products, algebraic theory of dimensional analysis, similarity and model laws, and derivation of model laws from differential equations. Applications include von Karman's theory of similarity in turbulent flow, boundary-layer theory, topics in open channel flow, model laws for pumps and turbines, topics in structural analysis and vibration theory, topics in the theory of heat. ½ or 1 unit.

351. Fundamental Concepts of Deformable Body Mechanics. This course is intended to provide an introduction to the general theories of kinematics of deformabl

bodies, general balance laws applicable to continuum mechanics, constitutive relations (stress-strain relations) as well as introductions to linear elasticity, linear viscoelasticity, and special concepts in other areas of solid mechanics and fluids. 1 unit. Prerequisite: Theoretical and Applied Mechanics 221; Mathematics 343 and 345.

360. **Continuum Mechanics, I.** A unified treatment of modern continnum mechanics: linear algebra and analysis, review of kinematics and general balance laws, general theory of mechanical constitutive equations (simple materials). 1 unit. Prerequisite: Theoretical and Applied Mechanics 351 or equivalent.

373. **Engineering Acoustics.** Same as Electrical Engineering 373. Development of the basic concepts needed for the understanding of mechanical and electric acoustic systems: vibrating string, vibrating membrane, plane waves, spherical waves, vibrating piston, acoustical filters, loudspeakers and microphones, principle of reciprocity, the ear, architectural acoustics. ¾ or 1 unit. Prerequisite: Mathematics 345 or equivalent, or consent of instructor.

392. **Analysis and Synthesis of Problems.** This course emphasizes the rational analysis of comprehensive problems and engineering systems. ½ or 1 unit. Prerequisite: Consent of instructor.

URBAN PLANNING

The Department of Urban Planning offers work leading to the master's degree. Students applying for admission must have a grade-point average of at least 3.75.

Master of Urban Planning. College graduates in liberal arts and sciences as well as architecture, urban planning, civil engineering, and landscape architecture can prepare themselves for careers in city, state, and regional planning.

The graduate program typically requires two years in residence, but a student with an undergraduate degree in urban planning may complete the program in a shorter period.

Specialization is encouraged, especially during the second year, in such directions as quantitative methods, social policies planning, implementation and intergovernmental relations, and urban design.

To qualify for this degree, a student must take (1) a total of at least six units of urban planning, and (2) at least two additional units to be chosen from the following fields: architecture, civil engineering, economics, geography, landscape architecture, political science, or sociology.

GRADUATE FACULTY

Professors: W. I. Goodman (Chairman of Department), J. M. Heikoff, S. Keyes, L. B. Wetmore.

Associate Professors: L. F. Blair, E. C. Freund, A. Z. Guttenberg, W. B. Hansen, R. J. Heifetz, J. R. Voss.

COURSES FOR GRADUATES

437. **Advanced Urban Planning Studio.** Analysis and synthesis problems related to design and development programming for cities, metropolitan areas, and urban regions. 1 to 2 units. Prerequisite: Urban Planning 337, 338, and 374, or consent of instructor.

487. **Seminar.** ½ unit. Prerequisite: Urban Planning 374.

488. **Urban Planning Research.** Individual and group instruction in the application of professional competences in urban planning to the analysis of urban

development problems and to the formulation of approaches to solution of such problems. ½ to 2 units. Prerequisite: Urban Planning 171 or consent of instructor.

492. **Seminar on Models for Directed Change.** Same as Sociology and Social Work 492. Construction and analysis of models for planned intervention at the personal, small group, and community levels. Construction of models as interpretations of behavioral science theory; extrapolating of hypotheses and of guides to intervention from the models. Readings from several disciplines as relevant. ½ or 1 unit. Prerequisite: Consent of instructor.

499. **Thesis Research.** ½ to 2 units. Prerequisite: Graduate standing in urban planning. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

337. **Urban Planning Studio, II.** The theory and development of the planning process as it applies to the study of an existing community, including visual surveys, data collection and analysis, "momentum projections," plan making, and implementation programs. 1 to 1½ units. Prerequisite: Urban Planning 236 or consent of instructor.

338. **Urban Planning Studio, III.** Contemporary theories of urban design and structure; planning and design of new communities; circulation and public facilities systems; studies of alternative patterns of growth. 1 to 1½ units. Prerequisite; Urban Planning 337 or consent of instructor.

351. **History of Urban Planning.** Description and analysis of the development of urbanization and the planning of communities from ancient times to the present, as related to environmental and cultural influences. ½ unit. Prerequisite: Urban Planning 171 or consent of instructor.

374. **Urban Planning Theory.** An examination of the urban planning function within a theoretical, methodological, institutional, and professional context. ½ unit. Prerequisite: Urban Planning 171 or consent of instructor.

376. **Planning Analysis.** Research and analytic techniques in urban planning; economic base and employment, population, market analysis; derivation and use of statistical data. ½ unit. Prerequisite: Urban Planning 171 or consent of instructor.

377. **Comprehensive Planning Procedure.** Design and plan-making techniques in urban planning; land use, circulation and community facilities; the development of the comprehensive general plan. ½ unit. Prerequisite: Urban Planning 171.

378. **Planning Legislation and Administration.** Legal tools of planning, zoning subdivision regulations; housing codes; methodology and application; administrative procedures; the place of planning in the structure of governments; the capital improvement program. ½ unit. Prerequisite: Political Science 150, 151 or 305, 306, or consent of instructor.

380. **Survey of Regional Planning.** Concepts and procedures for planning of regions: river valley, metropolitan, state, and national planning. ½ unit. Prerequisite: Urban Planning 171 or consent of instructor.

382. **The Language and Thought of Urban Planning.** The nature of urban planning thought; the meaning of its basic terms and concepts; the philosphic issues and choices of meaning facing the future professional; trends of thought in urban planning literature. ½ unit. Prerequisite: Consent of instructor.

384. **Urban Design and Planning Methods.** Concepts and techniques of urban analysis, plan making and implementation essential for effective interdisci

plinary work in urban design; case studies of major types of large-scale projects. ¾ unit. Prerequisite: Urban Planning 171 or consent of instructor.

VETERINARY MEDICAL SCIENCE

Candidates for the Master of Science and Doctor of Philosophy in Veterinary Medical Science must have a Bachelor of Science or a Doctor of Veterinary Medicine from a college or university approved by the University of Illinois. If they do not have a veterinary medical degree, their undergraduate training must be approved by the graduate faculty of the department as appropriate to advanced study. They must have a minimum grade-point average of 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

Areas of specialized study in veterinary medical science include anatomy, microbiology, parasitology, pathology, physiology, and pharmacology.

Students who intend to take graduate work for a Master of Science or Doctor of Philosophy in Veterinary Medical Science should include in their undergraduate program at least five hours of physics or mathematics, fourteen hours of chemistry, and fifteen hours of biological sciences.

Students planning to work toward the Doctor of Philosophy who enter the University of Illinois without previous graduate training are evaluated by the graduate faculty of the department at the end of their first year of residence in order to determine whether their progress is acceptable for work toward the doctorate. This evaluation is based in part upon an examination.

Departmental requirements for the Master of Science or Doctor of Philosophy in Veterinary Medical Science are described in a pamphlet which may be obtained from the office of the Dean of the College of Veterinary Medicine.

GRADUATE FACULTY

Professors: L. M. Jones (Dean of College of Veterinary Medicine), P. D. Beamer, L. E. Boley, P. R. Fitzgerald, H. W. Hannah, L. E. Hanson, H. J. Hardenbrook, R. D. Hatch, W. G. Huber, N. D. Levine, R. P. Link, J. E. Lovell, M. Ristic, L. E. St. Clair, A. G. Schiller, D. Segre, P. H. Silverman, J. Simon, E. Small, A. M. Watrach, G. T. Woods.

Associate Professors: D. H. Ferris, L. C. Helper, A. H. Killinger, C. D. Knecht, J. P. Manning, R. C. Meyer, W. L. Myers, W. M. Newton, H. A. Reynolds, F. E. Romack, A. H. Safanie, A. R. Twardock.

Assistant Professors: J. J. B. Anderson, Diane K. Normandin, R. E. Olsen, E. I. Pilchard, H. E. Rhoades, K. S. Todd.

COURSES FOR GRADUATES

408. Principles of Hematology. The cellular morphology of the blood and bone marrow of animals in health and disease. Lectures, discussions, demonstrations, and laboratory. ½ unit. Prerequisite: Veterinary Medical Science 301 or equivalent, or consent of instructor.

415. Mechanisms of Microbial Infections. Newer concepts of host-microorganism relations with emphasis on the dynamics and pathogenic mechanisms of microorganisms, immune responses and defense factors of the host, and pathogenesis of specific infections. Lectures, discussions, laboratory, and special problems. ¾ unit. Prerequisite: Microbiology 326 or Veterinary Medical Science 332, or equivalent; consent of instructor.

416. Epizootiology. Principles and problems of epizootiology with special consideration of the zoonoses; ecology of the host and parasite as related to resistance, adaptation, perpetuation, and distribution; the principles and factors in interference, carrier and latent states, reservoirs and control. 1 unit. Prerequisite: Veterinary Pathology and Hygiene 331, Veterinary Medical Science 332, or equivalent, or consent of instructor.

417. Medical Mycology. Study of the fungi that cause infections in man and animals; taxonomy, methodology, epidemiology, pathology, and diagnosis. 1 unit. Prerequisite: Microbiology 326, Veterinary Medical Science 332, or equivalent. RHOADES, WATRACH.

418. Concepts and Topics in Immunology. Same as Biology 418. Newer concepts and theories in the field of immunology, including theories of antibody formation and immunologic tolerance, regulation of the immune response, biosynthesis and structure of antibodies, and evolutionary aspects of the immune response. Lectures and discussion. ½ unit. Prerequisite: Consent of instructor. Microbiology 327 and Biology 307 recommended.

419. Animal Virology. Same as Microbiology 419. A discussion-laboratory with major emphasis on host-parasite relationships, natural history and epidemiology supplemented with appropriate laboratory techniques as they pertain to the major groups of animal viruses. ¾ unit. Prerequisite: Microbiology 326 and 327 or Veterinary Medical Science 331 and 332; Chemistry 350 or 354; consent of instructor.

425. Experimental Parasitology. Same as Zoology 425. A broadly based consideration of the relation of parasites to their hosts and to their environments, and of the factors which influence these relationships. 1 unit. Prerequisite: A laboratory course in parasitology or protozoology; organic chemistry; Chemistry 350; biochemistry and statistics are recommended.

440. Design and Analysis of Biological Experiments. Same as Agricultural Engineering, Agronomy, Animal Science, Dairy Science, Food Science, Forestry, and Horticulture 440. Statistical methods as tools for research. Principles of designing experiments and methods of analysis for various kinds of designs, including factorial experiments, are considered from the viewpoint of when and how to use them. ¾ unit. Prerequisite: Veterinary Medical Science 340 or equivalent.

445. Advanced Macroscopic Pathology. Concepts and interpretations of gross pathologic changes and the integration of host-parasite reactions. ½ or 1 unit. Prerequisite: Veterinary Medical Science 334 and 335, or equivalent; consent of instructor.

450. Advanced Veterinary Pathology. Advanced study of gross and microscopic pathology of diseases of domestic animals. 1 unit. Prerequisite: Veterinary Medical Science 335 or equivalent.

455. Comparative Oncology. A comparative study of the nature of mammalian and avian neoplasms based on general and special methods of tumor identification, classification, and experimentation. Lectures, demonstrations, and laboratory. 1 unit. Prerequisite: Veterinary Medical Science 445 and 459, or equivalent. Required course for students majoring in pathology in Department of Veterinary Medical Science.

457. Ultrastructural Pathology. Ultrastructural basis of pathologic processes occurring in animal tissues and cells. Lectures, discussions, and reports. ¾ or 1 unit. Prerequisite: Zoology 430; consent of instructor.

459. Advanced Correlative Pathology. Discussion and interpretation of disease processes of domestic animals. Emphasis on the correlation of gross, microscopic, and clinico-pathologic findings with alterations of function. 0 to 1½ units.

Prerequisite: Veterinary Medical Science 308, 335, 445, 450, or equivalent; consent of instructor.

460. **Advanced Veterinary Physiology.** Advanced study of physiology, nutrition, and biochemistry as related to problems in veterinary medical science. Problems studied include white muscle disease, sweet clover disease, ketosis, hypoglycemia and digestive disturbances. Laboratory includes planning, executing, and reporting a specific course project. 1 unit. Prerequisite: Veterinary Medical Science 315, 316, or equivalent; consent of instructor.

461. **Advanced Veterinary Pharmacology.** Evaluation of drugs, pharmacological aspects of biological antagonisms, chemotherapy, antibiotics, chelating agents and chemical biological correlation. ¾ unit. Prerequisite: Consent of instructor.

463. **Radioisotopes in Biological Research: Principles and Practice.** Same as Animal Science and Biophysics 463. Lectures, demonstrations, and laboratory on the fundamentals of radioisotope procedures and applications in biology and medicine. ¾ unit. Prerequisite: Quantitative chemistry; one year each of mathematics, physics, biology, and/or consent of instructor.

490. **Seminar.** Required of all graduate students whose major is veterinary medical science. ¼ unit.

491. **The Experimental Method in Veterinary Research.** Planning of experiments, use of controls, interpretation of results, sources of error, and writing the research report. ½ unit.

492. **Special Problems.** Basic and applied study including orientation and research on pertinent initial and continuing problems in the student's area of interest. ¼ to 1 unit. Prerequisite: Consent of instructor. STAFF.

499. **Thesis Research.** 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. **Gross Anatomy.** Systematic and topographic study and dissection of the dog. Lectures, discussions, demonstrations, quizzes, and laboratory. 1 unit. Prerequisite: Five hours of zoology; consent of instructor.

301. **Histology.** Structure of cells, tissues, membranes, vessels, lymphoid organs, hollow organs, skin and organs of special sense with special reference to domestic animals. 1 unit. Prerequisite: Registration in veterinary curriculum or consent of instructor.

302. **Gross Anatomy.** Comparative study and dissection of the domestic animals with special reference to development and adaptation to function. Lectures, discussions, demonstrations, quizzes, and laboratory. 1 unit. Prerequisite: Veterinary Medical Science 300 and 301, or consent of instructor.

303. **Microscopic Organology.** Microscopic study of the organ and systems of different domestic animals. Lectures, demonstration, laboratories, and quizzes. ¾ unit. Prerequisite: Veterinary Medical Science 300 and 301, or consent of instructor.

305. **Developmental Anatomy.** Development of organs and systems with emphasis on specializations in domestic and laboratory animals. Lectures and quizzes. ¾ unit. Prerequisite: Veterinary Medical Science 300 and 301, or consent of instructor.

307. **Correlative Mammalian Neuroanatomy.** Organization of nuclei and tracts of the central nervous system; morphologic specializations related to behavioral peculiarities of domestic and laboratory mammals; gross and microscopic examination of material from primates, rodents, carnivores, and ungulates. 1

unit. Prerequisite: Veterinary Biological Structure 300, Zoology 232, or consent of instructor.

308. Histochemistry. Methods used in histochemical and histological analysis in animals. Lectures, discussions, demonstrations, and laboratory. ½ or 1 unit. Prerequisite: Veterinary Medical Science 301 or equivalent, or consent of instructor.

315. Veterinary Physiology. Nervous systems respirations, acid-base balance, urine formation, body fluids and their regulation, muscular systems. Lectures, discussions, and laboratory. 1¼ units. Prerequisite: Consent of instructor.

316. Veterinary Physiology and Pharmacology. Blood and lymph, circulation, digestion, metabolism and endocrine systems. Lectures, discussions, and laboratory. 1 unit. Prerequisite: Veterinary Medical Science 315 or consent of instructor.

318. Pharmacology. General principles of pharmacy and an analysis of the action of chemical agents on physiological processes. Lectures, discussions, demonstrations, and laboratory. 1 unit. Prerequisite: Credit or registration in Veterinary Medical Science 315 and 316; consent of instructor.

320. Pharmacology and Toxicology. Principles of drug action and an analysis of action of chemical agents on living organisms including intoxications of domestic animals. Lectures, discussions, and demonstrations. 1 unit. Prerequisite: Veterinary Medical Science 318 or consent of instructor.

332. Veterinary Microbiology and Immunology. Lectures, discussions, and laboratories dealing with mechanisms of infection and resistance and the properties, pathogenesis, and control of viral infection of domestic and wild animals. 1 unit. Prerequisite: Veterinary Pathology and Hygiene 331 or equivalent; consent of instructor.

333. Protozoan and Arthropod Parasites. Protozoan and arthropod parasites affecting domestic animals and man. Lectures, discussions, and laboratory. ¾ unit. Prerequisite: Courses in chemistry or animal biology or both totaling twenty semester hours; consent of instructor.

334. General Pathology. The basic principles of pathological processes, including tissue injury and repair, circulatory and metabolic disturbances, inflammation and neoplasia. Lectures, quizzes, demonstrations, and laboratory. 1 unit. Prerequisite: Courses in histology, parasitology, physiology, and microbiology totaling twenty-five semester hours; consent of instructor.

335. Special Pathology. Disease processes affecting organs and anatomic systems and those occurring in specific diseases. Lectures, quizzes, demonstrations, and laboratory. 1 unit. Prerequisite: Veterinary Medical Science 334 or equivalent; consent of instructor.

336. Helminth Parasites. Helminth parasites affecting domestic animals and man. Lectures, discussions, and laboratory. ¾ unit. Prerequisite: Courses in chemistry or animal biology or both totaling twenty semester hours; consent of instructor.

340. Introduction to Applied Statistics. Same as Agricultural Engineering, Agronomy, Animal Science, Dairy Science, Food Science, Forestry, and Horticulture 340. Statistical methods involving relationships between populations and samples; collection, organization, and analysis of data; techniques in testing hypotheses with an introduction to regression, correlation, and analyses of variance limited to the completely randomized design and the randomized complete-block design. ¾ unit. Prerequisite: Mathematics 111 or 112 or 104, or equivalent.

369. Introduction to Human Ecology. Same as Anthropology, Geography, Health Education, Physiology, Psychology, Sociology, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations, and physiological, psychological, and sociological adjustments to environment, regulation of populations, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology; one year of anthropology, geography, geology, or sociology.

374. Problems in Human Ecology. Same as Anthropology, Geography, Health Education, Physiology, Psychology, and Sociology 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multidisciplinary studies of selected current problems. 1 unit. Prerequisite: Anthropology, Geography, Health Education, Physiology, Psychology, Sociology, or Zoology 369.

392. Special Problems. Individual research on a special problem chosen in consultation with the instructor and department head. ½ unit. May be repeated for a total of one unit. Prerequisite: Registration in veterinary medical curriculum with grade-point average of 3.5 or above. STAFF.

ZOOLOGY

See descriptions and course listings under Life Sciences, page 286.

UNIVERSITY OF ILLINOIS

Where to Write

ADMISSION
Office of Admissions and Records
100a Administration Building, Urbana 61801
or
The Graduate College
330 Administration Building, Urbana 61801

CHICAGO CIRCLE
The Graduate College
P.O. Box 4348, Chicago 60680

EMPLOYMENT (Hourly)
Director, Student Employment
707-109 South Sixth Street, Champaign 61820

EXTRAMURAL CLASSES
Division of University Extension
101 Illini Hall, Champaign 61820

FELLOWSHIPS, ASSISTANTSHIPS, OTHER FINANCIAL AID
The Graduate College
330 Administration Building, Urbana 61801
or the prospective major department

FOREIGN STUDENTS (Passport, Visa Assistance)
Director, Office of Foreign Student Affairs
310 Student Services Building, Champaign 61820

HOUSING
Director, Housing Division
420 Student Services Building, Champaign 61820

MEDICAL CENTER (Medical and Dental Sciences, Nursing, Pharmacy)
The Graduate College
P.O. Box 6998, Chicago 60680

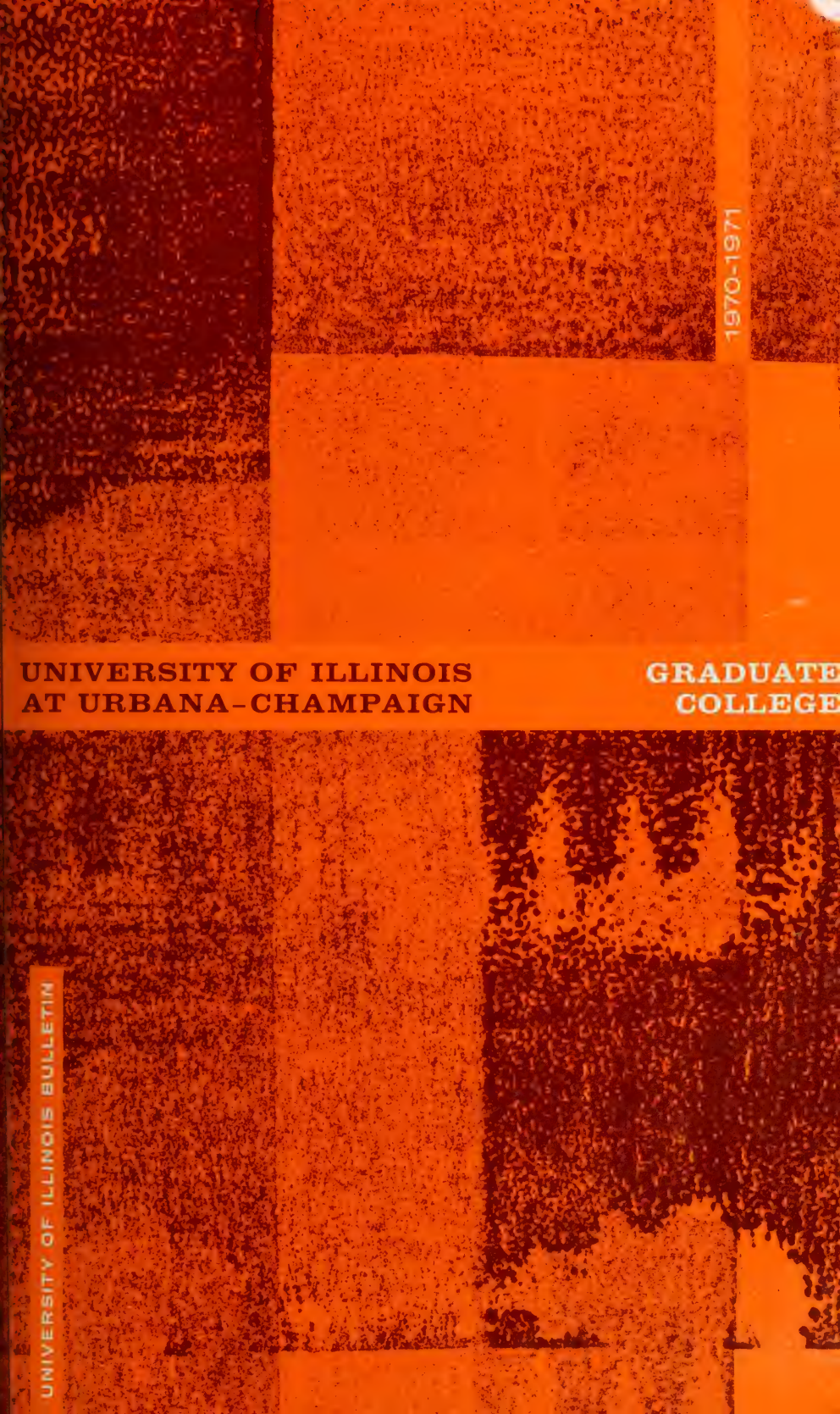
MOTOR VEHICLE AND BICYCLE REGISTRATION
Motor Vehicle Division
101 North Mathews Avenue, Urbana 61801

PUBLICATIONS
Graduate College Catalog; Time Table; Calendar;
Financial Aid for Graduate Students;
Saturday, Late Afternoon, and Evening Classes for Teachers
The Graduate College
330 Administration Building, Urbana 61801

DEPARTMENTAL BROCHURES
The prospective major department

SERVICES FOR PERMANENTLY PHYSICALLY HANDICAPPED STUDENTS
Division of Rehabilitation-Education Services
Rehabilitation-Education Center, Champaign 61820

VETERANS
Veterans Educational Benefits
707-109 South Sixth Street, Champaign 61820



1970-1971

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

GRADUATE COLLEGE

UNIVERSITY OF ILLINOIS BULLETIN

UNIVERSITY OF ILLINOIS BULLETIN. Volume 67, Number 109; May 1, 1970. Published twelve times each month by the University of Illinois. Entered as second-class matter December 11, 1912, at the post office at Urbana, Illinois, under the Act of August 24, 1912. Office of Publication, 114 Altgeld Hall, Urbana, Illinois 61801.

It is the policy of the University of Illinois to afford equal educational opportunities to qualified persons regardless of race, religion, or ethnic background.

1970-1971

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

GRADUATE COLLEGE

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1970-1971

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Political Science	Phillip Monypenny
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*Urban Planning	William I. Goodman
Veterinary Medical Science	L. Meyer Jones
Zoology	Robert L. Metcalf

*Awards master's degree only.

CALENDAR OF THE GRADUATE COLLEGE

Summer Session, 1970

June 22, Monday . . . . . Graduate registration. (Authorization cards distributed on alphabetical basis.)
June 23, Tuesday . . . . . Instruction begins.
July 4, Saturday . . . . . Independence Day (holiday).
July 17, Friday . . . . . Last day to add a course.
July 21, Tuesday . . . . . Last day to drop a course.
August 3, Monday . . . . . Last day for candidates for the master's degree in August to submit theses to Graduate College Office for approval of format.
August 3, Monday . . . . . No names will be added to the August graduation list after this date.
August 13, Thursday . . . . . Last day for candidates for the master's degree in August to deposit theses.
Aug. 14, Fri.-Aug. 15, Sat. . . . . Summer session examinations.
September 14, Monday . . . . . Last day for candidates for the master's degree in October to submit theses to Graduate College Office for approval of format.
September 14, Monday . . . . . No names will be added to the October graduation list after this date.
September 16, Wednesday . . . . . Last day for candidates for the doctoral degree in October to submit theses to Graduate College Office for approval of format.
September 28, Monday . . . . . Last day for candidates for the master's degree in October to deposit theses.
September 28, Monday . . . . . Last day for finals for the doctoral degree in October.
October 5, Monday . . . . . Last day for candidates for the doctoral degree in October to deposit theses and abstracts.

First Semester, 1970-1971

Note: Applications and schedule of test dates for the Graduate Student Foreign Language Tests (Educational Testing Service) will be available in the Graduate College, 330 Administration Building, by September 1, 1970.

Sept. 10, Thurs.-Sept. 12, Sat. to noon . . . . . Graduate registration. (Authorization cards distributed on alphabetical basis. Note: Employed school teachers registering for Saturday and evening classes should register Saturday morning, September 12. There will be no registration on Saturday, September 19.)

September 12, Saturday.....Last day for registration without payment of late registration fine.
September 14, Monday .....Instruction begins.
November 4, Wednesday.....Last day to add a course.
November 17, Tuesday.....Last day to drop a course.
November 25, Wednesday 1 P.M...Thanksgiving vacation begins.
December 1, Tuesday, 1 P.M.....Thanksgiving vacation ends.
December 12, Saturday.....Last day for preliminary examination for the Ph.D. degree if thesis credit earned during the semester is to apply to the third stage of program.
December 19, Saturday, 1 P.M.....Christmas vacation begins.

1971

January 1, Friday.....Earliest date to apply for National Defense Student Loan fund for 1971-1972. (Subject to change.)
January 4, Monday, 1 P.M.....Christmas vacation ends.
January 5, Tuesday.....Last day for candidates for the master's degree in February to submit theses to Graduate College Office for approval of format.
January 5, Tuesday.....No names will be added to the February graduation list after this date.
January 11, Monday.....Last day for candidates for the doctoral degree in February to submit theses to Graduate College Office for approval of format.
January 18, Monday.....Last day for candidates for the master's degree in February to deposit theses.
Jan. 18, Mon.-Jan. 26, Tues.....Semester examinations.
January 25, Monday.....Last day for finals for the doctoral degree in February.
February 1, Monday.....Last day for candidates for the doctoral degree in February to deposit theses and abstracts.

Second Semester, 1970-1971

Feb. 4, Thurs.-Feb. 6, Sat. to noon.Graduate registration. (Authorization cards distributed on alphabetical basis. Note: Employed school teachers registering for Saturday and evening classes should register Saturday morning, February 6. There will be no registration on Saturday, February 13.)
February 6, Saturday.....Last day for registration without payment of late registration fine.

February 8, Monday.....Instruction begins.
February 15, Monday.....Last day for application for fellowships for 1971-1972.
April 2, Friday.....Last day to add a course.
April 3, Saturday, 1 P.M.....Spring vacation begins.
April 12, Monday, 1 P.M.....Spring vacation ends.
April 15, Thursday.....Last day for preliminary examination for the Ph.D. degree if thesis credit earned during the semester is to apply to the third stage of program.
April 19, Monday.....Last day to drop a course.
April 23, Friday.....No names will be added to the June graduation list after this date.
April 30, Friday.....Honors Day. Classes dismissed at noon.
May 14, Friday.....Last day for candidates for the master's degree in June to submit theses to Graduate College Office for approval of format.
May 18, Tuesday.....Last day for candidates for the doctoral degree in June to submit theses to Graduate College Office for approval of format.
May 28, Friday.....Last day for candidates for the master's degree in June to deposit theses.
May 30, Sunday.....Memorial Day.
May 31, Monday.....Memorial Day holiday (no classes).
June 1, Tuesday.....Last day for finals for the doctoral degree in June.
June 1, Tues.-June 9, Wed.....Semester examinations.
June 7, Monday.....Last day for candidates for the doctoral degree in June to deposit theses and abstracts.
June 19, Saturday.....Commencement exercises.

Summer Session, 1971

June 21, Monday.....Graduate registration. (Authorization cards distributed on alphabetical basis.)
June 22, Tuesday.....Instruction begins.
July 4, Sunday.....Independence Day.
July 5, Monday.....Independence Day holiday (no classes).
July 16, Friday.....Last day to add a course.
July 20, Tuesday.....Last day to drop a course.
July 30, Friday.....Last day to apply for National Defense Student Loan funds for 1971-1972. (Early application advisable.)
August 2, Monday.....Last day for candidates for the master's degree in August to submit theses to Graduate College Office for approval of format.
August 2, Monday.....No names will be added to the August graduation list after this date.

August 12, Thursday..... Last day for candidates for the master's degree in August to deposit theses.

Aug. 13, Fri.-Aug. 14, Sat..... Summer session examinations.

September 15, Wednesday..... Last day for candidates for the doctoral degree in October to submit theses to Graduate College Office for approval of format.

September 20, Monday..... Last day for candidates for the master's degree in October to submit theses to Graduate College Office for approval of format.

September 20, Monday..... No names will be added to the October graduation list after this date.

September 29, Wednesday..... Last day for finals for the doctoral degree in October.

September 30, Thursday..... Last day for candidates for the master's degree in October to deposit theses.

October 6, Wednesday..... Last day for candidates for the doctoral degree in October to deposit theses and abstracts.

Deadline Dates for Submitting Applications for Admission or Readmission in September, 1971

July 28, Wednesday..... Last day for foreign students who have not attended a college or university in the United States to apply for admission in September, 1971.

August 25, Wednesday..... Last day for domestic students, or foreign students who have attended a college or university in the United States, to apply for admission or readmission in September, 1971.

The Graduate College

The University of Illinois offers programs leading to advanced degrees at the Urbana-Champaign campus, at the Medical Center campus (medical and dental sciences, pharmacy, and nursing), and at the Chicago Circle campus. The information contained in these pages applies to the Urbana-Champaign campus, located 130 miles south of Chicago in a community of about 97,000.

The Graduate College enrollment at Urbana-Champaign includes students from every state plus eighty-eight foreign countries and exceeds 8,400 out of a total campus enrollment of 32,000. A graduate faculty of nearly 1,800 offers instruction leading to advanced degrees in over one hundred fields of study. This large faculty and diverse student population, together with comprehensive library resources, numerous special laboratories and facilities, and a wide selection of social and cultural activities, make the University of Illinois at Urbana-Champaign an especially attractive environment for graduate study.

UNIVERSITY RESOURCES

Libraries

The University Library's resources for advanced study and research are outstanding. Its present collections now exceed 4,743,200 volumes, all but about 503,400 of them located in Urbana-Champaign. The remainder are held by the Library of Medical Sciences in Chicago and the library at Chicago Circle.

In addition to the figures for cataloged volumes cited above, the University Library contains approximately 566,000 pamphlets, 419,000 maps and aerial photographs, and 330,000 music scores and parts. More than 20,000 periodicals and newspapers are currently received.

Outstanding collections have been developed for a variety of fields. In the humanities, strong areas include classical literature, history, and archaeology; English literature of the sixteenth through the twentieth centuries; Romance and Slavic literature; German literature of the sixteenth and seventeenth centuries; American humor and folklore; and comparative philology. In the fine arts, collections in architecture, landscape architecture, and music are noteworthy.

Holdings in the social sciences include significant collections in history of the western United States, Abraham Lincoln and the Civil War, Latin America of the Revolutionary Period, medieval and modern Europe, Ireland, and the Slavic countries. Also noteworthy are collections in international law and relations, political science, law, economics, labor and industrial relations, and education.

Strong areas in science and technology include mathematics, chemistry, biological sciences (especially parasitology, entomology, and ornithology), physics, geology, engineering, and agriculture.

The Library's bibliographical facilities comprise a general catalog of more than 7,000,000 cards, printed catalogs of libraries, e.g., the Bibliothèque Nationale, British Museum, and Library of Congress; national and trade bibliographies of all countries for which such works have been issued; bibliographies of special subjects; and similar aids.

A number of departmental and divisional libraries are maintained. The main library houses the following principal collections: Classics, Commerce, Education and Social Science, English, History and Philosophy, Human Relations Area Files, Library Science, Map and Geography, Modern Language, Newspaper, Physical Education, and Rare Book Room.

Elsewhere on the campus are the following departmental libraries: Agriculture, Architecture and Fine Arts, Biology, Ceramics, Chemistry, City Planning, Engineering, Geology, Home Economics, Communications, Labor and Industrial Relations, Landscape Architecture, Law, Mathematics, Music, Natural History Survey (entomology and other biological sciences), Physics, and Veterinary Medicine, and the Undergraduate Library.

Further facilities available for graduate students are the general bookstacks, housing about 2,500,000 volumes, and over 300 carrels in the bookstacks, assigned to individuals engaged in extended study and research. Interlibrary loan service is provided for those engaged in research for dissertations.

Special Laboratory Facilities

Children's Research Center. The Children's Research Center, which was opened in late 1966, is a two-storied building of 25,000 square feet of

offices and laboratories. Situated on the south edge of campus, it shares a site with the Adler Zone Center operated by the State of Illinois Department of Mental Health. Patients from the Adler Center, which serves an eighteen-county area in East Central Illinois, often participate in research projects conducted at the Children's Research Center.

The Children's Research Center contains laboratories specializing in research on children in such areas as psychophysiology, motor performance and play research, attention and memory, speech development and speech compression, infant attention and learning, psychopharmacology, and learning disabilities. In addition, four normal nursery school classes of children are conducted in the building, and the children are available for participation in research. Satellite facilities for research with children, operated by the Children's Research Center, are located in neighboring public schools and state institutions. Several trailer laboratories are used by the staff in conducting research on the site at public schools.

Coordinated Science Laboratory. The Coordinated Science Laboratory, an interdisciplinary Laboratory in the College of Engineering, is organized to provide an interdisciplinary research environment to stimulate interaction among faculty and students from Engineering as well as other colleges. The laboratory contributes to the graduate instructional program of the University by providing research possibilities for graduate students in all of its programs.

Faculty members typically hold joint appointments in the Coordinated Science Laboratory, where they conduct their research and supervise the research of graduate students, and in an academic department, where they teach. Graduate students conducting thesis research in the Laboratory earn their advanced degrees in the departments in which they are enrolled. There are research activities in information science, control of dynamic systems, circuits and communications systems, switching systems, plasma physics, rarefied gas dynamics, computer operations and research (including the plasma display panel), electrical breakdown in ultra-high vacuum, physics of the atmosphere, semiconductor physics, surface physics and surface chemistry, and studies to develop aids for the handicapped.

The facilities of the Laboratory are generally available to its own staff and students, and to other staff and students by special arrangement. Facilities include a Control Data Corporation 1604 computer and an associated graphics terminal, a Michelson far-infrared interferometer (Research and Industrial Company Fourier Spectrophotometer), and a Jarrell Ash Vacuum Scanning Spectrometer (1200 to 62,000 angstroms). In the shop area, special facilities include an electron beam welder, two electrical discharge machines, and equipment for chemical milling and photo-fabrication.

Computer-based Education Research Laboratory (CERL). CERL has designed and is operating PLATO III, a flexible and sophisticated computer-based education (CBE) system. The system utilizes a Control Data Corporation 1604 computer as the central control unit for up to twenty student terminals; all student terminals can be used independently and simultaneously. In addition to a twenty-terminal CBE classroom at CERL, there are three other classrooms located at educational institutions in the Urbana-Champaign community and one in another part of the campus. The system has been used for more than 60,000 student-contact hours of credit teaching. Some of the areas in which studies have been conducted are electrical engineering, geometry, biology, nursing, library science, algebra, mathematics drill, computer programming, and foreign languages. The PLATO III system is the predecessor for a system of 4,000 student terminals under the control of a central computer which is to be in operation in 1972-1973.

Digital Computers. See Department of Computer Science, page 143.

Electron Microscope Facility. The Electron Microscope Laboratory, located in the basement of Bevier Hall, is a central facility for instruction and research in behalf of all University departments. It is equipped with a Siemens Elmiskop 1, a highly modified Hitachi HS-6, RCA models EMU-3E, EMU-3D, EMU-3C, EMU-2C, and EMU-2E electron microscopes, and a Cambridge Stereoscan electron microscope. Ancillary equipment includes seven ultramicrotomes, three shadowcasters, an RCA electron diffraction unit, and three complete photographic darkrooms and general facilities.

The instructional program consists of the following courses: Biology or Chemistry 423, Electron Microscopy; Biology or Chemistry 429, Electron Microscopy with Laboratory; Biology or Chemistry 493, Advanced Electron Microscopy; Biology 430, Biological Ultrastructure; and seminars and special workshops. The facilities are available for research conducted by qualified members of the faculty and graduate students.

Materials Research Laboratory. The Materials Research Laboratory supports the training of graduate students and research in the materials sciences in cooperation with the departments of Ceramic Engineering, Chemistry and Chemical Engineering, Electrical Engineering, Metallurgy and Mining Engineering, and Physics. Emphasis is placed on interdisciplinary research which is basic to an understanding of the solid state of matter. The Laboratory contains machine and glass shops, cryogenic facilities, high temperature, toxic materials, x-ray, electron microscope and electron microprobe laboratories, a chemical analysis laboratory with

emission and mass spectrographic equipment and a 3 MEV electron accelerator.

Physical Environment Unit. The facilities of the Physical Environment Unit provide unique opportunities for pursuing interdisciplinary researches on the responses of biological systems to stresses imposed by the physical environment. An altitude chamber accommodating six human beings permits simulation of altitudes up to 45,000 feet. Air temperature and humidity may be controlled in this chamber to permit investigation of the combined stresses of low environmental pressure and heat or cold. Additional controlled environment rooms provide flexible areas where special test facilities may be installed. The Physical Environment Unit serves as the focus for teaching and research in the course sequence on ergonomics, offered jointly by the departments of Physiology and Biophysics, and Mechanical and Industrial Engineering. All departments and divisions of the University needing closely controlled environment conditions for research or instructional work may utilize the special skills and equipment available in the Unit.

Radioisotope Laboratory. The Radioisotope Laboratory is an all-University facility for graduate training and research involving the use of the tracer technique with carbon-14 or tritium or both. It is equipped with liquid scintillation spectrometers, vibrating reed electrometers, gas counters, radio-gas chromatography units, high vacuum systems, combustion set-ups, and auxiliary radiochemical equipment.

A prerequisite for research in the Laboratory is the carbon-14 course, Chemistry and Animal Science 496, which emphasizes experimental techniques employed in the synthesis, degradation, isolation, establishment of purity, and assay of radioactive carbon compounds. Members of the staff present this course one semester each year.

Social and Cultural Facilities

Students at the University of Illinois have a wide choice of activities and facilities available to them. Campus events announced in a weekly calendar include musical programs, lectures, University forums, campus and traveling theatrical productions, weekend movies and dances, and fine arts and scientific exhibitions. The Illini Union, the campus social center, has lounges, dining facilities, and recreational and meeting rooms available to students and faculty.

The Krannert Art Museum provides galleries for displaying the University's permanent collection of art works and for presentation of other exhibitions. A University Festival of Contemporary Arts, held every two

years, includes special events and exhibits in the areas of art, architecture landscape architecture, urban planning, drama, motion picture, literature printing, dance, and music.

The Krannert Center for the Performing Arts, with its four separate and specialized theatres, provides excellent facilities for orchestra, opera choral organizations, theatre, and dance. The professional programs in these areas are housed in the Center, which schedules numerous performances by local groups and outside organizations.

ADMISSION

General Requirements

Prospective students are urged to apply for admission as early as possible Applications for September admission are accepted from December 1 to September 1, but departmental enrollment quotas are usually filled by May 1. Applications for admission in February and June are accepted beginning in October and March, respectively. For students from other countries, the latest date to apply is six weeks in advance of the registration period.

Students may obtain admission forms from the Office of Admissions and Records, 100a Administration Building, or from the Graduate College 330 Administration Building.

The Graduate College considers for admission only those applicants who hold a baccalaureate or an equivalent degree comparable to that granted by the University of Illinois and whose scholastic average is at least 3.5 on a scale where A = 5.0. Admission averages for master's candidates are computed from the last sixty hours of work completed. For doctoral candidates the admission average includes all graduate work as well as the last sixty semester hours of undergraduate work.

The final decision on admission, however, rests with the applicant's proposed major department, which may set standards significantly higher than those of the Graduate College. In evaluating the applicant's record faculty members in the proposed major department pay special attention to the student's qualification for advanced study in the area. Unfortunately the limited availability of staff and facilities prevents the College from admitting all those who qualify.

Admission Status

Each new or readmitted student is issued one of the following types of permits to enter:

Status No. 1: Full graduate standing at the master's level.

Status No. 2: Full graduate standing at the post-master's or doctoral level.

Status No. 3: Limited standing. This is a probationary status for students (1) who have less than a 3.5 grade-point average; (2) who have departmental deficiencies to be removed during the first year; (3) who are currently enrolled as undergraduates; (4) who present foreign credentials which must be evaluated at the time of registration.

Permits for Status 1, 2, or 3 are issued with the understanding that the major department will determine deficiencies or prerequisites and will advise the student with respect to his program of study.

Status No. 4: Non-degree standing. This status is limited only to those applicants who have *no intention* of pursuing a graduate degree at the University of Illinois. Non-degree students are advised in the Graduate College Office, 330 Administration Building.

A student admitted or readmitted with non-degree standing for the fall, spring, or summer term must apply for readmission for the following September if he expects to register that term.

Physical Examination

Each new student must present evidence of satisfactory physical and mental health to the Director of Health Services. When a Permit to Enter is issued to a new student, he will receive a Student Health Report form that he should take immediately to a physician of his choice. The student is responsible for insuring that the Student Health Report is completed, signed, and mailed in advance of the registration period. Admission requirements are not satisfied until the Report is received by the Office of Admissions and Records.

Tuberculosis Control

During the registration period each new, transfer, or readmitted student must: (1) take a tuberculin skin test and report to the University Health Service for a reading within forty-eight to seventy-two hours after application, or (2) present evidence of freedom from tuberculosis as evidenced by University of Illinois or a public health agency certificate (skin test or X-ray) dated within the last twelve months.

Persons who have a positive reading must have a chest X-ray taken by the Health Service. Persons with a history of positive reaction to tuberculin will not be skin tested but will be required to have a chest X-ray made by the Health Service. Health Service X-rays are made without charge.

Failure to comply with the tuberculosis control requirements will result in cancellation of registration.

Summer Session

In addition to a two-semester academic year, the University conducts an eight-week summer session at Urbana-Champaign. New students applying for admission to the Graduate College for the summer term should submit applications for admission as soon as possible after February 15, and preferably no later than May 15.

If an application for admission as a degree candidate is received after May 15, admission for the summer can be granted only for non-degree registration. Students who intend to pursue a degree but who are admitted for non-degree registration in the summer should request consideration for degree status at the Graduate and Foreign Admissions Office, 100a Administration Building, immediately after instruction begins.

Former graduate students expecting to attend the summer session should read the following section on readmission to determine whether an application for readmission is necessary. If one is required, it should be submitted no later than May 15.

Readmission

Former students must submit an application for readmission if any one of the situations described below applies. In this context, a student who registers but later drops all of the courses he is taking that term is considered not to have registered at all. Unless otherwise stated, the situations described apply to both degree and non-degree students last registered in an extramural course as well as to those registered in campus courses.

(1) Students who did not register at any time during the previous *calendar* year.
(2) Students who wish to enroll in the fall term but were not registered *degree candidates* in the previous spring semester or summer session.
(3) Students who wish to register in the spring semester but were not registered in the fall term.

Former students need not apply for readmission to the summer session if they were registered the previous fall or spring or *on the campus* the previous summer. Authorization cards for registration for the summer session are prepared automatically for these students.

All students with non-degree status must apply for readmission for the fall term.

Applications for readmission to a spring or fall semester should be submitted as early as possible after October 1, and no later than two weeks before registration begins. Applications for the summer session should be filed as soon as possible after February 15.

Graduate Study by Seniors at the University of Illinois

With the approval of his undergraduate college, a senior at the University of Illinois whose academic average for his junior and senior work is 4.0 or above may apply for admission to the Graduate College if he is *within five hours* of his baccalaureate degree. If he is *within six to ten hours* of that degree, he may apply to take some work for graduate credit. Forms describing the procedure to be followed are available at the Graduate College Office.

Foreign Applicants

Inquiries concerning admission should be directed to the Graduate and Foreign Admissions Office, 100a Administration Building, University of Illinois, Urbana, Illinois 61801, U.S.A.

The applicant must submit official records of all his higher educational training, including certificates of degrees, with the dates the degrees were conferred. These records must be certified as true copies of the originals by the proper school official of each institution attended after graduation from the secondary or high school program. The scholastic records should include by years a list of individual subjects studied and the credit and grades received for each course. If the applicant has attended school in a country following the British educational system (including India), his records must show certification of the class or division in which the degrees, diplomas, and certificates were earned. If available, a statement of the rank in class and the total number of students in the class should be included. The school records and certificates should be submitted in the language and form in which they were originally issued. If the original document is not in English, it must be accompanied by an authenticated English translation. Applicants for admission in applied art and music or architectural design must send samples of their work.

Eligible applicants whose native language is not English must take the Test of English as a Foreign Language (TOEFL), given several times a year throughout the world. To make arrangements to take the TOEFL, write directly to the Educational Testing Service, Box 592, Princeton, New Jersey 08540, U.S.A. If an applicant has already taken this test, he should request the Educational Testing Service to send his test score to the Graduate and Foreign Admissions Office, 100a Administration Building, University of Illinois, Urbana, Illinois 61801, U.S.A. Final admission status for those required to take the TOEFL is determined after the scores have been received. Students with unsatisfactory scores are not accepted. If the score is satisfactory, but shows a need for further English study, a placement test is required on arrival at the University. On the basis of this test, students

may be required to take noncredit courses in English. These courses usually reduce a student's registration in credit courses; thus, the time to complete degree requirements is extended.

A Certificate of Eligibility for the Student (F) visa (Form I=20) is sent with a letter of admission. Usually, students who receive United States government grants or who participate in United States government-sponsored programs must obtain Exchange-Vistor (J) visas, for which a Certificate of Eligibility (Form DSP-66) is required. The Graduate and Foreign Admissions Office or the sponsoring agency sends this form, if applicable.

All foreign applicants for admission (except those in Canada and Mexico) must submit five International Postal Reply Coupons (Coupon-responsé international) of the Universal Postal Union with their applications. Usually, these coupons can be purchased at local post offices in the native country. These coupons defray some of the costs of international airmail postage incurred by the University in corresponding with applicants abroad.

FINANCIAL AID

Various types of financial assistance are available each year to promising students in all fields of study in the Graduate College. The principal kinds of awards are listed below.

Fellowships

University Fellowships. University Fellowships are awarded by fellowship committees in a competition open to students in all fields of study. The stipend for a University Fellowship is not less than $2,000 for the academic year, or $2,500 for eleven months, with exemption from tuition and all regular fees which are assessed at the time the student registers. A student who receives a University Fellowship may accept, if offered, a part-time teaching or research assistantship to a maximum of one-quarter time. University Fellows must carry a full program, normally four units or the equivalent.

Fellowships are also provided for teaching assistants for the summer session only. These awards are restricted to graduate students who have held teaching assistantships at the University of Illinois at Urbana-Champaign for at least half-time for both semesters of the preceding academic year, who have earned not less than two units of graduate credit during that year, and who have demonstrated superior scholarship. Fellows are selected on the basis of a campus-wide competition. The Summer Fellowships carry sti-

pends of $500 for the eight-week summer session, plus tuition and fee exemptions.

In addition to the awards for which all graduate students are eligible, there are Fellowships in the Creative and Performing Arts. In the selection of the recipients of these awards, special consideration is given to the applicant's creative achievements and promise. Students in the fields of dance, theatre, architectural design, landscape architecture, sculpture, painting and print-making, graphic design, industrial design, urban planning, and musical performance and composition are eligible. Applications should be directed to the appropriate department.

Graduate College Fellowships are awarded on the basis of need and academic promise rather than past performance. The stipend is the same as for University Fellowships.

National Defense Graduate Fellowships. National Defense Graduate Fellowships are financed under Title IV of the National Defense Education Act of 1958, and are administered with the cooperation of participating universities. This program assists students who are preparing to teach in the nation's colleges and universities. An NDEA Title IV Fellowship, which is restricted to citizens or permanent residents of the United States, is awarded for a three-year period to a student beginning his graduate studies. The stipend for twelve months is $2,400 for the first year, plus an allowance for dependents and exemption from tuition and all regular fees which are assessed at the time the student registers. A holder of a Title IV Fellowship may also be appointed as a quarter-time teaching or research assistant.

Under Title VI (Modern Foreign Languages) of the National Defense Education Act, the University of Illinois at Urbana-Champaign participates in programs in Asian, Russian, and Latin-American Language and Area Studies. These fellowships, restricted to citizens or permanent residents of the United States, are intended for students planning a college or university teaching career or other career centering on problems of the language area. The stipend for the fellowship, which is renewable, is $2,250 for the academic year, or $2,700 for the summer and academic year, plus an allowance for dependents. Title VI Fellowships also provide for the payment of tuition and fees.

Requests for information and application materials should be directed to the student's prospective department.

Office of Education Fellowships. Fellowships are available in specialized areas of teacher training under the Education Professions Development Act. Fellowships may be available in various fields of study for training teachers and other personnel for schools at all levels—pre-school through junior college and college.

A student who intends to major in a department in the College of Education should direct inquiries to the Coordinator of Graduate Study, 110 Education Building, indicating his particular field of interest. Inquiries about teacher-training programs in subject-matter fields should be directed to the student's major department.

Industrial, Endowed, and Special Fellowships and Traineeships. Various industrial firms, foundations, governmental agencies, and private individuals have generously donated funds to support special fellowships for graduate students at the University of Illinois at Urbana-Champaign. The stipends and supplemental allowances of these fellowships vary, and most of them are restricted to students in particular areas of study. For information on specific programs, write to the Fellowship Office, Graduate College, 311 Administration Building.

Traineeships

National Science Foundation Traineeships. Under this program, grants are made directly to the participating institutions, which select promising individuals for NSF traineeship awards. Appointments may be made only to citizens of the United States (or native residents of a United States possession) who are enrolled in programs leading to an advanced degree in the mathematical, physical, medical, biological, or engineering sciences, anthropology, communications, economics, geography, the philosophy of science, linguistics, political science, psychology, and sociology. Also included are interdisciplinary areas which are comprised of overlapping fields among two or more sciences.

The basic stipend for twelve months is $2,400 for Trainees at first-year level, $2,600 for those at intermediate-year level, and $2,800 for those at terminal-year level, plus exemption from tuition, service fee, and hospital-medical-surgical fee. An allowance of $500 is granted for each dependent. NSF Trainees may elect a nine-months' tenure, rather than twelve months, with a corresponding decrease in the stipends and allowances. In addition, traineeship awards may be available for the summer session only.

Inquiries concerning traineeships should be directed to the appropriate department.

Public Health Service Traineeships. These traineeships support students enrolled for advanced training in health and health-related areas, such as social work, mental health, vocational rehabilitation, speech correction, the life sciences, the agricultural sciences, psychology, biochemistry, medical librarianship, sanitary engineering, and sociology.

A traineeship is virtually equivalent to a fellowship since the stipend is

considered a tax-free gratuity and no duties are required other than those directly contributing to the training program. The stipends vary from $1,800 to $2,800 or more, depending on the recipient's level of study and area of specialization. Most Public Health Service Traineeships provide tuition and fees and dependency allowances. Inquiries should be directed to the student's major department.

Assistantships

The various departments of the University employ graduate students as teaching or research assistants. The usual appointment is for half-time service, at a salary of $2,900 for the academic year (September to June). Applications may be made directly to the appropriate department.

Assistants holding appointments ranging from 25 through 67 per cent of full-time service are exempt from the tuition and service fee, but not from the hospital-medical-surgical fee. For more detailed information concerning fee assessment, see pages 42 to 53.

Appointments for part-time assistantships also are available in non-teaching bureaus and agencies. For further information and application materials, write directly to: Bureau of Business Management, Bureau of Economic and Business Research, Center for Instructional Research and Curriculum Evaluation, Institute of Communications Research, Institute of Government and Public Affairs, Institute for Research on Exceptional Children, Physical Environment Unit, or Small Homes Council-Building Research Council. All agencies may be addressed in care of the University of Illinois, Urbana 61801.

Part-time appointments as student residence hall counselors are also available. These provide cash stipends plus room and board and the same exemption from tuition and the service fee accorded other staff members. For further information, students should write to the Student Affairs Coordinator, URH-174 Weston Hall, Champaign, Illinois 61820.

Tuition and Waivers

These awards provide exemption from the tuition and service fee, but not from the hospital-medical-surgical fee, for the academic year and the summer session immediately preceding or following. Students holding these awards must be in residence and must register for at least three units each semester during the academic year. The holder of the tuition and fee waiver may also accept part-time or incidental employment not to exceed twenty hours a week either within or outside the University.

Veterans who are admissible to a graduate program and who meet cer-

tain residence requirements may be eligible for exemption from tuition under the state statute concerning Military Scholarships. Further information may be obtained from the Director of Student Financial Aids, 707 South Sixth Street, Champaign, Illinois 61820.

How to Apply

Application materials with instructions may be obtained from the Graduate College or from any graduate department. Only one application form is needed to apply for any of the types of financial aid listed on pages 24 to 28. A specially marked application for the National Defense Education Act Title VI Fellowships may be obtained from Professor Joseph H. D. Allen, Chairman of the Committee on National Defense Foreign Language Fellowships, 221 Lincoln Hall, Urbana, Illinois 61801.

To be considered for a University Fellowship beginning in June or September, the application must be filed with the major department no later than February 15, but preferably early in January. (The School of Music deadline is February 1, with the exception that applications in the area of voice are due January 15.) These deadlines do not apply to applications for assistantships, tuition and fee waivers, and certain industrial and special fellowships. However, applicants for such appointments are strongly urged to submit their applications as early as possible since many departments offer assistantships and other awards at the same time they consider applications for fellowships.

Fellowships, assistantships, and tuition and fee waivers can be awarded only to students who are enrolled in the Graduate College or who have completed procedures for admission. Students should consult the Application for Admission form for full instructions.

Announcement of Awards

The first list of fellowship awards is announced after March 1. The University adheres to the resolution adopted by the Council of Graduate Schools in the United States which provides that recipients must accept or decline by April 15. If the recipient of an award indicates his acceptance before April 15, he will have complete freedom through April 15 to resign in order to accept another appointment. After April 15, however, he may not accept another award without obtaining a formal release from the first commitment.

It is understood that the award of a graduate appointment for one year involves no commitment for continued support by the University for subsequent years.

Loan Funds

Information and application forms concerning loans from the University, the National Defense Education Act, the Illinois Guaranteed Loan Program, the United Student Aid Fund, short-term emergency loans, and other loan funds may be obtained from the Student Financial Aids Office, 707 South Sixth Street, Champaign, Illinois 61820. The amount of the loan which is finally approved is based on the financial need of the applicant as computed from information obtained from the applicant and the availability of funds. Priority is given to students with superior academic backgrounds.

University Loans. A student may apply to borrow from the University Loan Fund an amount not to exceed $1,000 per year or a total of $2,500. Loans are repayable, at a minimum of $30.00 monthly, at an interest rate of 3 per cent annually, beginning four months after leaving the University, with the requirement that all loans be repaid within forty-four months.

National Defense Education Act Loans. Eligible graduate students may request financial assistance from funds provided to the University under Title II of the National Defense Education Act. The limit is $2,500 per year to a total of $10,000. Repayment begins in monthly installments, at an interest rate of 3 per cent annually, nine months after the borrower has ceased to pursue a full-time course of study. The entire loan must be repaid within ten years after repayment begins.

Up to 50 per cent of a National Defense Education Act loan is cancelled if the borrower serves as a full-time teacher in a public or non-profit private school in the United States. This applies to elementary or secondary schools and institutions of higher education. Such cancellation is at the rate of 10 per cent of the loan, for each academic year, or its equivalent, of such service. Also, if teaching service is performed in an elementary or secondary school officially classified as having a high percentage of students from low income families, or if the borrower is a teacher for the handicapped in a public or private non-profit school, cancellation is at the rate of 15 per cent per year with no limit on total cancellations.

Illinois Guaranteed Loan Program. A borrower must be a citizen of the United States and a bonafide resident of the state of Illinois. All fifty states are participating in the Guaranteed Loan Program. A non-Illinois resident must seek assistance through the program in his home state.

Graduate students may apply to borrow from a minimum of $300 to a maximum of $1,500 during an academic year while enrolled for full-time study.

No loan is granted in an amount which exceeds the established educa-

tional expenses at the eligible college selected by the student, minus other financial aid received from or through the University.

Repayment of principal is required at a minimum monthly rate of $30 beginning nine months after the borrower ceases to be a full-time student, and the loan must be paid in full within six years from the date the borrower was last a full-time student.

The maximum interest rate permitted by law is 7 per cent simple interest, which begins on the date of the loan. If the family of the borrower has an annual "adjusted income" (gross income less 10 per cent and deductions for dependents) of less than $15,000, the federal government pays all of the interest while the borrower is in college, and the borrower pays all interest during the period of repayment. A student not qualified for federal interest subsidy is required to pay his own interest on a semi-annual basis from the day the money is first made available to him.

United Student Aid Fund Loans. A graduate student may apply for assistance up to $1,500 per year to a combined total of $7,500. (This total includes loans not in excess of $1,500 a year as an undergraduate student.) The amount of a loan is determined on an individual basis. No notes under this plan may bear more than 7 per cent simple interest. Repayments begin the first day of the fifth month after the holder ceases to be a full-time student. The normal repayment period is thirty-six months, but larger loans may be repaid over periods ranging up to one hundred and twenty months. Monthly installments may not be less than $30.

Short-Term Emergency Loans. Short-term emergency loans up to a maximum of $100 may be requested by students. The loan must be paid within sixty days, or by the end of the semester, whichever date is earlier. Request forms may be obtained from the Student Financial Aids Office.

Other Loan Funds. The Student Financial Aids Office maintains a list of additional loan sources, such as private foundations, church-related sources, and bank sources. This information will be provided upon request to a student needing financial assistance.

ACADEMIC AND OTHER REGULATIONS

Responsibility for complying with the regulations of both the Graduate College and his major department and for fulfilling all requirements for his particular degree rests with the student. These requirements are outlined in this catalog and, in many cases, in departmental brochures. The Graduate College calendar included in this catalog is also printed separately and may be obtained from the Graduate College, 330 Administration Building.

Petitions

The normal procedures and requirements of the Graduate College are indicated in this catalog. A student may petition the Dean of the Graduate College for exceptions, but he should do so only after consultation with his adviser. Forms for such petitions may be secured in the departmental offices and at the Graduate College.

Residence

Each degree candidate must spend a certain period of time in "residence." Residence is realized when a student lives in the community, or its immediate surroundings, and devotes an appreciable portion of his time to graduate studies. A student who is regularly employed outside the Urbana-Champaign community is not considered to be in residence even though he is registered in a campus course.

Work Completed Elsewhere

A candidate for the doctorate, who has received a master's degree from a recognized institution, is considered to have completed the first stage of a doctoral program (see page 37). If the courses involved are to be used in partial fulfillment for the requirements for the doctorate, the candidate is examined on the content at the time of the preliminary examination.

A student who has completed graduate work in a recognized institution, but has not taken a degree, may petition to obtain credit toward an advanced degree by passing examinations in this work. Admission to such examinations requires the approval of the departments concerned and of the Dean of the Graduate College. The acceptance of credit for work completed elsewhere does not reduce the residence requirement for an advanced degree.

Time Limit for Advanced Degrees

A candidate for the master's degree must complete all requirements for the degree within five calendar years after his first registration in the Graduate College.

A candidate for the doctor's degree must complete all requirements for this degree within seven calendar years after his first registration in the Graduate College, except as noted in the following paragraph.

A candidate for the doctorate who has received a master's degree elsewhere must complete all requirements for the degree within five years after his first registration in the Graduate College. A student whose program of study is significantly interrupted after he receives a master's degree from the

University of Illinois and who later returns to work for his doctorate will have five years from the date he returns to complete degree requirements.

Unit Credit for Courses

Graduate credit is measured in terms of units. One unit is considered the equivalent of four semester hours. The normal program for a full-time graduate student is four units each semester or two units for an eight-week summer term. With his adviser's approval, the student may take a maximum of five units in a semester, or two and one-half units in a summer term.

Grading System

Final grades for courses are recorded as follows: A, B, C, D (lowest passing grade), and E (failure), with numerical computations of grade-point averages based on a system where A = 5.0. Other symbols in use, but not included in the computation of grade-point averages, are:

W—Officially withdrawn from a course.

Ex—Temporarily excused. Used by the instructor if he has granted an extension of time to a student who has not completed the final examination or other requirements for the course. An excused grade must be replaced by a letter grade no later than the end of the next semester in which the student is registered or one year from the date the excused grade was incurred if the student does not register. Failure to complete the work within these time periods results in a grade of E.

Df—Grade temporarily deferred. Used only in research (the courses numbered 499) and other approved courses that extend beyond one semester.

S or U—Satisfactory or Unsatisfactory. Used only as final grades for the thesis research course (499) and in certain approved non-credit courses.

P or F—Pass or Fail. Used only if a graduate student has registered for a course under the pass-fail option with the approval of his major department. See below.

Pass-Fail Option

Subject to the restrictions imposed by the major department, a graduate student with the approval of his adviser may register for graduate credit under this option with the understanding that there must be at least two units of course work on the Urbana-Champaign campus with grades of A through D for every unit taken on a pass-fail basis. Students may elect this option only during advance enrollment, during regular registration days, or within the first two weeks of the term. At any other time, requests to take

a course on this basis, or to retain the course and drop the option will not be granted.

Scholastic Requirements

The minimum grade-point average required by the Graduate College for an advanced degree is 3.75 (A = 5.0); the minimum average required by a department may be higher than 3.75. The grade-point average (GPA) is computed at the end of every term and is shown on the Semester Report that is mailed to each student as soon as possible after the final day of examinations. The GPA computation includes only units with grades of A through E. It excludes grades of Pass, Fail, Ex, Df, S, U, and credit for work completed elsewhere. A student who receives a grade of E should consult with his adviser to determine whether he should repeat the course and whether or not the credit he earns in that course, if repeated with a passing grade, may be applied to an advanced degree.

A student who has completed four or more units with an average of less than 3.75 receives a warning letter from the Graduate College. If the average has not been raised to 3.75 upon the completion of four additional units, or if the average falls below 3.75 thereafter, the student is disqualified as a degree candidate. Attainments other than satisfactory grades, however, are taken into consideration by the adviser and the major department in determining qualifications for an advanced degree.

Maximum and Minimum Registration

Students holding University Fellowships or other fellowships awarded by the University must carry a full program (four units or the equivalent). Those awarded tuition and fee waivers must carry a minimum program of three units or the equivalent. The academic work carried by assistants and others on the University staff is limited by statute, and those employed outside the University are expected to reduce their programs of study in accordance with these regulations. The maximum amount of academic work is determined by the terms of employment as follows:

	Maximum Registration	
Terms of Employment	*Semester*	*Summer Session*
Full time	1 unit	1 unit
Three-fourths time	2 units	1¼ units
Two-thirds time	2¼ units	1½ units
One-half time	3 units	1¾ units
One-third time	3¾ units	2 units
One-fourth time	4 units	2 units

Exceptions to the *semester* schedule are possible by means of a special petition procedure. This privilege does not apply to summer session.

Military Deferment

The Selective Service System through the local board determines the student's deferment status. Generally, the following criterion is used as a guide for deferment:

Verification from the Graduate College that the student is satisfactorily pursuing a full-time program of study. A full-time program involves (1) three or more units of graduate study, (2) a program of both graduate and undergraduate courses equivalent to twelve or more semester hours, (3) two and one-half units plus an appointment for not less than one-third time, or (4) two units of graduate study and an appointment as a teaching or research assistant for not less than one-half time.

It is the student's responsibility to initiate the appropriate request or form that will enable the University to send accurate information to his local board. A student who has been issued a permit to enter the Graduate College but who has not had an opportunity to register, may request the Selective Service clerk in the Office of Admissions and Records, 69 Administration Building, to notify his local board of his acceptance.

A student who is registered should obtain a Status Form for Graduate Students Seeking Deferment from his major department or the Graduate College. This form must be completed by the student, certified by the executive officer of the major department, and filed with the Office of Admissions and Records, 69 Administration Building, at the times shown below:

(1) When the student first registers and every September thereafter.
(2) When a "change of program" is initiated which will reduce the student's program to less than three units or the equivalent (twelve semester hours).
(3) When the student's degree objective or anticipated degree date changes.

The University may inform and justify, but has no control over decisions made by the Selective Service System. A student who is reclassified by his board and who wishes to appeal the reclassification should notify his local board in writing that he wishes to appeal. The right to appeal is forfeited thirty days after the reclassification date. A graduate student ordered to report for induction may be authorized postponement of induction until the end of his academic year. It is recommended that graduate students ordered for induction consult with the Selective Service Counselor, 130 Student Services Building.

Conferring of Degrees

Advanced degrees are conferred in February, June, August, and October, except that the doctorate is not awarded in August. No student will be

awarded more than two graduate degrees for work completed at the University of Illinois.

THE MASTER'S DEGREE

Master's degrees are offered in the fields indicated on pages 8 and 9. Unless otherwise specified in the departmental listings, the credit requirement for this degree is at least eight units. Three of the eight units must be in courses numbered in the 400 series, and two of these three must be in the major field.

Residence

A candidate must spend at least two semesters, or the equivalent, in residence and must earn at least half the required units while in residence. See page 31.

Thesis

A student electing or required to write a master's thesis should file the subject of the thesis at the Graduate College, 321 Administration Building, at least six weeks prior to graduation. No more than three units of thesis credit may be included in an eight-unit program. Credit in thesis research can not be applied to a degree unless a thesis is submitted.

For specific instructions regarding the format of the thesis, the student should obtain a copy of the leaflet, *Instructions for Preparation of Theses*, from the Graduate College Thesis Office, 306 Administration Building.

Master's Degrees in Teacher Education

Programs leading to master's degrees for teachers are available in the areas listed below and in a number of the departments of the College of Education (see page 158).

Agricultural Education—page 69
Art—page 89
Biological Sciences and General Science—page 254
Chemistry—page 116
Earth Science—page 212
English—page 189
English as a Second Language—page 189
French—page 204
Geography—page 209
German—page 217
Health Education—page 220
Home Economics—page 229
Latin—page 136
Mathematics—page 283
Music—page 305
Physical Education—page 322
Physical Sciences—page 325
Physics—page 325
Russian—page 356
Social Studies—page 360
Spanish—page 372
Speech—page 377
Speech Correction—page 378

Applicants who have not completed requirements of a four-year undergraduate curriculum leading to teacher certification may be admitted to these programs on the approval of the appropriate adviser and the Coordinator of Teacher Education, but they must complete teacher certification requirements, as well as the usual program requirements, in order to qualify for the master's degree in teacher education.

Requirements for Teacher Certification

The requirements for teacher certification, referred to above, are of three kinds. The student must meet general education requirements and teaching field requirements equivalent to those of the appropriate undergraduate curriculum. The determination of this equivalence is ordinarily made by the adviser. The student must also meet the professional education requirements equivalent to those of the undergraduate curriculum. If the student has not fulfilled this requirement (eighteen hours of credit in professional education courses), he may take the courses listed below to satisfy this requirement.

Educational Psychology 211 (or equivalent) ..... 3 semester hours
Elementary Education 231 or Secondary Education 241 ..... 3-5 semester hours
Educational Practice 232 or 242 ..... 5 semester hours
History and Philosophy of Education 304 ..... ½ unit
History and Philosophy of Education 305 ..... ½ unit
Educational Psychology 311 ..... ½ unit
Educational Psychology 312 ..... ½ unit

If the credit in the above list is given in terms of units, it may be assumed that such credit will apply toward requirements for the master's degree as well as the requirements for certification. Educational Psychology 211 is prerequisite to Educational Psychology 311 and 312, and may be waived on the basis of a non-credit proficiency examination administered by the Department of Educational Psychology. A successful proficiency examination, however, does not serve to reduce the eighteen hours of professional education courses required for certification.

Educational Practice 220, 232, 238, or 242, whichever is appropriate, is required of all students seeking teacher certification. Educational practice (student teaching) is administered under the Illinois Teaching Experience Laboratory. Information concerning student teaching in various fields may be obtained at the following locations in the Education Building: Secondary Education, Room 398; Elementary Education, Room 304; Special Education, Room 210; and Vocational and Technical Education, Room 347.

Students requesting educational practice for teacher certification should request application forms through one of the offices listed above. It is essen-

tial that this be done immediately on receiving notice of admission to the Graduate College. Only students admitted to fifth-year teacher education programs as listed on page 35 may apply for student teaching assignment.

To be considered for admission to student teaching, graduate students must have completed one semester of work on the Urbana-Champaign campus and be registered in a teacher education program. Registration in student teaching requires concurrent registration in the appropriate section of the specialized course in technics of teaching.

Students pursuing both certification and master's degree requirements should anticipate at least the equivalent of three semesters of full-time study.

THE DEGREE OF DOCTOR OF PHILOSOPHY

The degree of Doctor of Philosophy is offered in the fields indicated on pages 8 and 9. General requirements are described below; special requirements are given in departmental listings. For information about doctoral level professional degrees in business administration, education, law, music, and psychology, see the appropriate sections.

Residence

A doctoral program includes three stages. At least two of these stages must be completed in residence; the residence period must include two successive semesters in the second or third stage.

The *first stage* ends when the candidate receives a master's degree or earns the equivalent credit (eight units or thirty-two semester hours); the *second stage* comprises eight units of work, fulfillment of departmental requirements, and a successful preliminary examination; the *third stage* comprises research and seminars (eight units), preparation of the dissertation, and the final examination. For maximum time allowed, see page 31.

Programs of Study and Areas of Specialization

A student's courses and research are planned with his adviser. Consideration is given to previous academic training, career objective, the general requirements of the Graduate College and the major department. The student should become familiar with these requirements and satisfy them as soon as possible.

The major area of specialization is a selection of courses which are closely related but not all necessarily offered by the major department.

If a student elects or is required to declare a minor outside his major department, the selection must be approved by the department or division

concerned. A minor area of specialization is a group of courses that are related but may be offered by more than one department.

Each department determines its own foreign language requirement, if any, or the options that may be substituted. Special courses, without graduate credit, designed for students preparing to meet a language requirement are offered by the modern language departments.

Preliminary Examination

To enter the third stage of a doctoral program (see page 37), a candidate must pass a preliminary examination to test his qualifications for further advanced study and research. The examination may be written, oral, or both, according to departmental requirements. The candidate is certified for admission to the third stage by a committee appointed by the Dean of the Graduate College on the recommendation of the executive officer of the major department. To maintain his status as a degree candidate, a student who has passed the preliminary examination must register each semester until the degree is conferred (see third stage requirements, page 37).

If a student does not complete his degree requirements within five years after passing his preliminary examination, a second preliminary examination is required.

Thesis

The Doctor of Philosophy is primarily a research degree and the candidate must demonstrate his capacity for independent research by the production of an original thesis on a topic within his major field of study. The subject of the thesis must be reported to the doctoral committee and to the Graduate College at the time of the preliminary examination.

Candidates engaged in thesis research may find it desirable or expedient to publish, prior to the conferral of the degree, certain findings that later will be incorporated in the dissertation. In this case appropriate acknowledgment of the earlier publication should be included in the dissertation. The Graduate College encourages such publication, but the thesis in its entirety may not be published before all degree requirements have been completed.

Directions regarding the format of the thesis are given in the leaflet, *Instructions for Preparation of Theses*, which may be obtained in the Graduate College Thesis Office. The candidate must submit to the Graduate College, no later than the date specified in the current calendar, (1) the original and the first carbon copy (or two copies reproduced by an approved method)

of his thesis, and (2) one typewritten copy of an abstract not exceeding six hundred words.

Each candidate who passes the final examination must pay a $25.00 microfilm fee. This provides for (1) microfilming the complete thesis, with one copy deposited in the University of Illinois Library, and (2) publication of the abstract in *Dissertation Abstracts*.

Final Examination

The candidate is admitted to the final examination by the Dean of the Graduate College upon completion of the dissertation and the recommendation of the major department.

OTHER EDUCATIONAL OPPORTUNITIES

Traveling Scholar Program

The University of Illinois is one of eleven midwestern member universities of the Committee on Institutional Cooperation and a participant in the Committee's Traveling Scholar Program. This program enables an advanced graduate student to work at another campus for a semester in order to take advantage of special course offerings or research facilities, such as a unique laboratory or library collection, not available at his own institution. A CIC Traveling Scholar registers at his home university, and credit for the work is recorded there. Appointment as a Traveling Scholar is based upon the individual submission to the Graduate College of an application which carries the strong endorsement of the student's major department and the approval of the host institution. Each university retains the right to accept or reject any student desiring to study under its auspices. A student interested in participating in the program should consult with the head of his major department.

International Programs and Studies

The University of Illinois offers many opportunities for graduate students to pursue international studies both at home and abroad. Graduate student research forms an integral part of University projects in India, Sierra Leone, Jamaica, Iran, Puerto Rico, Tunisia, and other countries. Research opportunities, particularly in non-Western countries, are also available through the Midwest Universities Consortium for International Activities, of which the University of Illinois is one of five member universities, and the Center for International Comparative Studies on the Urbana-Champaign

campus. For full information on these opportunities, as well as other graduate study abroad programs and a wide range of courses and seminars in international studies, please write for the handbook "International Programs and Studies at the University of Illinois at Urbana-Champaign," which may be obtained from the Office of International Programs and Studies, Room 301, 409 East Chalmers Street, Champaign, Illinois 61820.

Military Science (Reserve Officers' Training Corps)

Army R.O.T.C. is offered at the University of Illinois as outlined in the Undergraduate Study catalog.

A student in a graduate or professional course who completed the basic course as an undergraduate or who received appropriate credit may apply for admission to the advanced course any time prior to the beginning of the last two years of his graduate program, providing he meets the eligibility requirements listed in the Undergraduate Study catalog.

A special two-year advanced program is offered for selected students who have two academic years remaining at the University, but who did not take the basic course through on-campus instruction. Under this program, the basic course is accomplished by completion of a summer training camp of not less than six weeks' duration at an active army installation. While attending this camp, students are paid at the same rate as a basic trainee; and they are allowed travel expenses to and from camp.

Further information may be obtained from the Professor of Military Science, 113 Armory, University of Illinois, Champaign, Illinois 61820.

Auditing Privileges

A graduate student or a person not registered in the University of Illinois is permitted to attend classes (other than laboratory courses) as an auditor, provided a Visitor's Permit bearing the approval of the instructor and the Dean of the Graduate College is filed with the Records Office, 69 Administration Building. A student should not enter on his program card any courses which he plans to attend as an auditor. Visitor's Permits are available from the Graduate College, 330 Administration Building.

Extramural Courses

Graduate courses in a few areas of study are offered at various centers throughout the state. A student who is employed full time may not register for more than one unit of extramural course work in any one semester nor

more than one unit in any combination of extramural and campus courses.

Because extramural course work is not considered work in residence, credit earned in such courses can be applied toward an advanced degree only if (1) the courses are approved in advance by the adviser and constitute part of a well integrated program, and if (2) the total extramural credit does not exceed two units (the Ed.M. and the Advanced Certificate excepted). Credit earned in extramural courses can not be applied toward the second stage of a doctoral program (see page 37).

Correspondence Courses

Credit earned in correspondence courses can not be applied toward an advanced degree. However, it is possible to fulfill certain prerequisites or remove deficiencies through correspondence work. A catalog of correspondence courses offered by the University of Illinois may be obtained from the Division of University Extension, Correspondence Courses, 104 Illini Hall.

HOUSING

The University of Illinois is committed to a policy of nondiscrimination in housing with respect to race, religion, and national origin. University-owned housing facilities are operated on this basis. Privately-owned housing which is University approved or listed must also be operated in compliance with this policy. The owner or manager of this type of housing files with the University Housing Division a pledge not to discriminate on the grounds of race, religion, or national origin. A Housing Review Committee has been appointed by the Chancellor to assist in the implementation and enforcement of nondiscrimination in housing.

If anyone has reason to believe that an owner or manager of certified housing has refused or failed to rent to an individual because of the individual's race, religion, or national origin, he should communicate this information directly to the secretary of the Housing Review Committee or to any member of the committee. The secretary can be reached at 333-0613. The individual who alleges discrimination need not be University-affiliated; furthermore, the particular rental unit involved in the alleged discrimination need not be one that is listed with the University, provided that the owner or manager has a nondiscriminatory pledge on file.

The University has residence facilities in Arthur Hill Daniels Hall and Stuart Pratt Sherman Hall, two separate residence hall complexes for approximately 1,000 single graduate students, both men and women.

Semester contract food service in undergraduate dining halls can also be arranged. In addition, the University provides a limited number of apartments for married students, with priority in assignment given to part-time research and teaching assistants.

Applications for accommodations in the University graduate residence halls or the University-owned apartments for married students may be obtained from the Housing Division, 420 Student Services Building, Champaign, Illinois 61820. The Housing Division also maintains a courtesy list of private apartments and rooms available in homes in the community. Office hours are from 8:00 A.M. to 5:00 P.M. Monday through Friday, and from 9:00 A.M. to 12:00 noon each Saturday. During the weekend immediately prior to registration, in September and February, office hours also are maintained from 1:00 to 4:00 P.M. Saturday and 10:00 A.M. to 4:00 P.M. Sunday. University offices are not open on national holidays.

FEES AND EXPENSES

Expenses

Graduate residence halls, operated by the University, offer single rooms at rates ranging from $518 to $614 for the academic year and double rooms from $454 to $582 per person for the same period. A board contract may be purchased for one semester for $300.

Monthly rentals for University-owned apartments for married students range from $83 for a one-room efficiency to $114 for larger units, plus utilities.

Single rooms in private residences in the community range from $45 to $60 a month and double rooms from $40 to $55 per person. Privately-owned apartments also are available at rates ranging from about $100 to $200 per month.

For further information concerning housing, see page 41.

Tuition and Fees, 1970-1971

(Subject to change.)

Tuition and other fees, as indicated below, are payable in full when the student registers, unless the installment plan of payment is elected. An additional charge of $2.00 is made for this privilege.

SEMESTER

	Full Program		*Partial Programs*			
	Range I		**Range II**		**Range III**	
	Above 10 hours Above 2½ units		**Above 5 through 10 hours Above 1¼ through 2½ units**		**Above 0 through 5 hours Above 0 through 1¼ units**	
	Resident	**Non-resident**	**Resident**	**Non-resident**	**Resident**	**Non-resident**
Tuition (except those holding exemptions)	$123.00	$477.00	$ 87.00	$330.00	$51.00	$186.00
Service Fee[1]	40.00	40.00	25.00	25.00	10.00	10.00
Hospital-Medical-Surgical Fee[2]	18.00	18.00	18.00	18.00	18.00	18.00
Total	$181.00	$535.00	$130.00	$373.00	$79.00	$214.00

[1] Persons on appointment for at least 25 per cent of full time on the academic, administrative, or permanent nonacademic staff of the University, or on the staffs of allied agencies, and persons registering *in absentia* or in courses conducted off campus are exempt from the service fee.

[2] Students presenting evidence of equivalent coverage may receive a waiver of the insurance portion of the hospital-medical-surgical fee upon approval of a petition submitted to the University Insurance Office not later than the final day established for full refund of fees. A signed waiver and assumption of responsibility are required. All on-campus students are required to pay the McKinley Hospital portion ($9.00) of the hospital-medical-surgical fee. Persons registered for thesis research *in absentia* are not assessed the hospital-medical-surgical fee.

The above charges are effective for the first semester of 1970-1971. Subject to completion and occupation of the Intramural-Physical Education Building, the service fee for the second semester and thereafter will be increased by $18.00, $12.00, and $5.00 for Ranges I, II, and III respectively.

TWELVE-WEEK SUMMER TERM (SOCIAL WORK AND INSTITUTES) AND ELEVEN-WEEK SUMMER LAW PROGRAM*

	Full Program		*Partial Programs*			
	Range I Above 8 hours Above 2 units		**Range II** Above 4 through 8 hours Above 1 through 2 units		**Range III** Above 0 through 4 hours Above 0 through 1 unit	
	Resident	**Non-resident**	**Resident**	**Non-resident**	**Resident**	**Non-resident**
Tuition (except those holding exemptions)	$ 82.00	$318.00	$ 58.00	$220.00	$34.00	$124.00
Service Fee[1]	44.00	44.00	29.00	29.00	15.00	15.00
Hospital-Medical-Surgical Fee[2]	18.00	18.00	18.00	18.00	18.00	18.00
Total	$144.00	$380.00	$105.00	$267.00	$67.00	$157.00

* Students registered in *either one* of the five and one-half week summer law sessions pay one-half of the tuition and service fee established for the twelve-week term, rounded to the next higher even dollar. They are also subject to the same hospital-medical-surgical fee applying to registrants in the eight-week summer session.

[1] Persons on appointment for at least 25 per cent of full time on the academic, administrative, or permanent nonacademic staff of the University, or on the staffs of allied agencies, and persons registering *in absentia* or in courses conducted off campus are exempt from the service fee.

[2] Students presenting evidence of equivalent coverage may receive a waiver of the insurance portion of the hospital-medical-surgical fee upon approval of a petition submitted to the University Insurance Office not later than the final day established for full refund of fees. A signed wavier and assumption of responsibility are required. All on-campus students are required to pay the McKinley Hospital portion $9.00 of the hospital-medical-surgical fee. Persons registered for thesis research *in absentia* are not assessed the hospital-medical-surgical fee.

EIGHT-WEEK SUMMER SESSION

	Full Program		*Partial Programs*			
	Range I		**Range II**		**Range III**	
	Above 5 hours Above 1¼ units		**Above 2½ through 5 hours Above ¾ through 1¼ units**		**Above 0 through 2½ hours Above 0 through ¾ unit**	
	Resident	**Non-resident**	**Resident**	**Non-resident**	**Resident**	**Non-resident**
Tuition (except those holding exemptions)	$ 62.00	$239.00	$ 44.00	$165.00	$26.00	$ 93.00
Service Fee[1]	29.00	29.00	22.00	22.00	8.00	8.00
Hospital-Medical-Surgical Fee[2,3]	18.00	18.00	18.00	18.00	18.00	18.00
Total	$109.00	$286.00	$ 84.00	$205.00	$52.00	$119.00

[1] Persons on appointment for at least 25 per cent of full time on the academic, administrative, or permanent nonacademic staff of the University, or on the staffs of allied agencies, and persons registering *in absentia* or in courses conducted off-campus are excempt from the service fee.

[2] Students presenting evidence of equivalent coverage may receive a waiver of the insurance portion of the hospital-medical-surgical fee upon approval of a petition submitted to the University Insurance Office not later than the final day established for full refund of fees. A signed waver and assumption of responsibility are required. All on-campus students are required to pay the McKinley Hospital portion ($9.00) of the hospital-medical-surgical fee. Persons registered for thesis research *in absentia* are not assessed the hospital-medical-surgical fee.

[3] If insurance coverage for the period between the close of the summer session and the beginning of the first semester is not desired, one-half of the assessed fee ($9.00) will be refunded if requested in writing prior to the final date established for full refund of fees.

ZERO CREDIT COURSES (URBANA-CHAMPAIGN)

Students (except those holding exemptions) who register in zero-credit courses pay tuition and fees as follows:

(1) Students taking one or more courses for zero credit, but no courses for credit, are assessed for tuition and fees as follows:
   a. For study on campus: One-half of the Range III resident tuition and one-half of the Range III service fee, each rounded to the next higher even dollar, and the full hospital-medical-surgical fee. (No charge will be assessed, however, for University employees who register, at the request of their department, only in zero-credit courses especially established to improve the work of the employee.)
   b. For study off campus, including graduate registration *in absentia:* One-half of the Range III resident tuition, rounded to the next higher even dollar, but no service fee and no hospital-medical-surgical fee.

(2) Students taking one or more courses for zero credit with one or more courses for credit are assessed tuition and fees on the basis of the credit course(s) only.

Residence Classification

The residence classification of an applicant is determined on the basis of information given on his application and other credentials. Tuition is assessed in accordance with this decision. Errors in residence classification or in assessments discovered following registration may result in adjustments of charges. If the student believes he has a legitimate cause for change of status from nonresident, he shall pay the nonresident tuition but may, by petition, on a form provided by the Office of Admissions and Records, request a change. Petitions are considered *within thirty days* from the date designated in the official University Calendar as that upon which instruction begins for the academic period for which the charge is payable. However, if the nonresident tuition was not assessed on or prior to that date, the claim for refund may be filed *within thirty days* after the nonresident tuition was assessed and the student was given notice of its assessment. Tuition and fees will not be adjusted for that academic term because of change in residence classification if the petition is not filed within these time limits. Additional evidence to substantiate a request may be required. If the student expects to ask for a change of residence classification, it is advisable for him to request the adjustment be made prior to the registration period.

In the event a student who claims he is a resident student is dissatisfied with an adverse ruling of the Director of Admissions and Records, he may obtain a review of such decision by the Legal Counsel of the University by filing a written request with the Director of Admissions and Records

within twenty days after he has been notified of the ruling. In such cases, the decision of the Legal Counsel is final.

Further information concerning residency may be secured by contacting the Office of Admissions and Records, 177 Administration Building, Urbana, Illinois 61801. A brochure entitled *Regulations Governing Assessment of Resident or Nonresident Student Fees* is also available in that office.

Special Fees

Below is a partial list of special fees pertaining to graduate students. A complete schedule of tuition and fees may be obtained from the Office of Admissions and Records, 132 Administration Building.

Application Fee. Beginning in September, 1970, each applicant for admission or readmission to the University must submit with his application nonrefundable fee of $15.00. This fee is not applicable on tuition and other fees.

Duplicate Identification Photo Cards—$1.00. (Payable at the Bursar's Office.)

Flight Training. In addition to the regular tuition and fees, students taking flight training pay for each flight course a materials and supply fee of $550.00; for each glider course a special fee of $245.00; and for registration in Aviation 100, a course fee of $125.00. (*These fees are not included in scholarship and staff fee exemption provisions.*)

Late Registration Fine—$15.00. All students, whether on appointment or not, who complete registration for courses on campus after the close of the regular registration, are subject to this fine in addition to the tuition and fees. A student's registration is not complete until his tuition and fees have been paid in full, or he has made arrangements with the Bursar's Office for deferment of payment. Students who register late in any term pay the same tuition and fees as students who register at the beginning of the term.

Off-Campus Courses. Students registered *for credit* in off-campus work, such as field courses, are exempt from the service fee. They pay the same tuition, resident or nonresident, assessed for campus registration of equal credit and the hospital-medical-surgical fee. Students registered in courses for *zero credit*, including graduate registrations *in absentia*, pay one-half of the Range III resident tuition, regardless of the residence classification, rounded to the next higher even dollar, but no service fee and no hospital-medical-surgical fee.

Visitor's Fee (Campus Courses). Persons not otherwise registered in University courses and students registered on campus on a partial program fee schedule (Range II or III) are charged a fee of $15.00 for each course attended as a visitor only.

Assessments and Exemptions

Assessments. For tuition and fee assessment purposes, a staff appointment must be to an established position for a specific amount of time and a salary commensurate with the percentage of time; it must require service for not less than three-fourths of the term. This is interpreted as a minimum of three and one-half months in a semester, nine weeks in a quarter, and six weeks in an eight-week summer session. Staff tuition and fee privileges do not apply to students employed on an hourly basis in either an academic or nonacademic capacity, or to persons on leave without pay.

For fee assessment purposes, a *permanent* nonacademic employee is defined as a person who has been assigned to an established, permanent, and continuous nonacademic position and who is employed for at least 25 per cent of full time.

University employees appointed to established Civil Service positions whose rate of pay is determined by negotiation, prevailing rates, union affiliation, etc., are not considered as paid on an hourly basis and are entitled to the same tuition and fee privileges accorded to other staff members under the regulations.

Any student who resigns his staff appointment, or whose appointment is cancelled before rendering service for at least three-fourths of the term, becomes subject to the full amount of the appropriate tuition and fees for that term unless he withdraws from his University classes at the same time the appointment becomes void. Such students are not assessed tuition and fees for that term if they file clearance for graduation within one week after the appointment becomes void.

Unless otherwise exempted by Board of Trustees' authorization, the payment of tuition and fees is required of individuals employed by the University or allied agencies under appointment for less than 25 per cent of full time.

Exemptions. CIC Traveling Scholars from other collegiate institutions pay appropriate tuition and fees at their home institutions; they pay no tuition or fees for their work on this campus. Other students may be exempted from one or more of the usual charges if they qualify under the following conditions:

A. APPLICATION FEE IS WAIVED FOR:

(1) Members of the academic and nonacademic staff of the University and of the allied agencies on appointment at the time of application.
(2) Extramural non-degree applicants.
(3) Graduate extramural degree candidates until such time as they apply for work in residence.

(4) Foreign students recommended by the Latin-American Scholarship Program of American Universities (LASPAU) and the African Graduate Program (AFGRAD).

B. TUITION IS WAIVED FOR:

(1) Holders of tuition waiver scholarships.
(2) All academic employees of the University or of allied agencies on appointment for at least 25 per cent but not more than 67 per cent of full-time services.
(3) All permanent nonacademic employees of the University or allied agencies on appointment for at least 25 per cent of full time who register in University courses in Range II or III.
(4) Holders of graduate tuition and fee waivers awarded by the Graduate College.
(5) Holders of grants or contracts from outside sponsors which provide payments to cover the total costs of instruction.
(6) Cooperating teachers and administrators who receive assignment of practice teachers. (Exemption is provided in one semester, quarter, or summer session for each semester or quarter of assignment within the same calendar year—September through August.)
(7) University employees registered at the request of their departments in zero credit courses especially established to improve the work of the employee.
(8) Academic staff members emeriti.

C. NONRESIDENT PORTION OF TUITION IS WAIVED FOR:

(1) All staff members (academic, administrative, or permanent nonacademic) on appointment for at least 25 per cent of full time with the University or the allied agencies.
(2) The faculties of state-supported institutions of higher education in Illinois.
(3) The teaching staff in the private and public elementary and secondary schools in Illinois.
(4) The spouses and dependent children of all staff members (academic. administrative, or permanent nonacademic) on appointment with the University or the allied agencies, and of those listed in item 2 above. (Dependent children are those who qualify as dependents for federal income tax purposes.)
(5) The spouses and dependent children of fellows and trainees who are employed as teaching assistants to the extent permitted by their fellowship appointment.
(6) Persons actively serving in one of the Armed Forces of the United

States who are stationed and present in the state of Illinois in connection with that service.

(7) The spouses and dependent children of those listed in item 6 above, as long as they remain stationed, present, and living in this state.

For those listed in items 1 through 5 above who are eligible for such waiver in the final term of the academic year, this privilege is also extended to the summer session immediately following.

D. SERVICE FEE IS WAIVED FOR:

(1) All staff members of the University or allied agencies on appointment for at least 25 per cent of full time.
(2) Holders of graduate tuition and fee waivers awarded by the Graduate College.
(3) Students registered *in absentia.*
(4) Students registered in courses taught off campus, or in off-campus Engineering 102 (Cooperative Program) only.
(5) Holders of grants or contracts from outside sponsors if this fee is charged to the contract or grant funds.
(6) Cooperating teachers and administrators described under B, item 6, page 49.
(7) University employees registered at the request of their departments in zero-credit courses especially established to improve the work of the employee.
(8) Academic staff members emeriti.

E. HOSPITAL-MEDICAL-SURGICAL FEE IS WAIVED FOR:

(1) Persons registered for doctoral thesis research *in absentia.*
(2) Holders of grants or contracts from outside sponsors if this fee is charged to the contract or grant funds.
(3) Students for whom this fee has been assumed by the Graduate College
(4) University employees registered at the request of their departments in zero-credit courses especially established to improve the work of the employee.
(5) Persons registered only in Engineering 102 (Cooperative Program) and/or other off-campus courses for zero credit.
(6) Upon approval of a petition presented to the University Insurance Office not later than the final day established for full refund of fees, students presenting evidence of equivalent coverage are exempted from the insurance portion of the hospital-medical-surgical fee. Except as indicated above, all students are required to pay the McKinley Hospital portion of the fee ($9.00).

F. SUMMER SESSION TUITION AND FEES ARE WAIVED FOR:

1) Students hold academic appointments to the close of the final term of an academic year either as employees or fellows, and for whom tuition and/or fees have been provided through waiver or through cash payment by an outside agency, are entitled to a waiver of the same kinds of tuition and fees for the summer session immediately following, provided they hold no appointments during that summer session.

2) Students holding summer session appointments as fellows or as employees are subject to such tuition and fees as would be assessed in accordance with the principles expressed above.

Vehicle Registration

Any individual after completing his academic registration at the Urbana-Champaign campus, regardless of the number of semester hours or graduate units carried, who desires to park on University parking lots or University streets as permitted by the current regulations, is required to register his vehicle. Such registration must be completed within one school day of the acquisition of each vehicle.

Registration should be accomplished during the regular academic registration at the Armory, otherwise at the Office of Motor Vehicle Registration, 101 North Mathews Avenue, Urbana.

If an automobile has a current faculty-staff registration permit, additional student registration is not required.

Student automobile registrations are effective from September 1 to September 1 of each year. A nonrefundable annual registration fee of $5.00 is assessed each student registering an automobile during the year.

Additional information concerning parking limitations and other details of the student automobile regulations, including monetary and other penalties for non-compliance or violations, is available from the Office of Motor Vehicle Registration. Any questions as to whether a student or his automobile is included under these regulations should be referred to that office.

The Office of Motor Vehicle Registration requires the registration of all motorcycles, motor scooters, and motor bicycles. The fee for such registration is $3.00 per year.

Out-of-state motorcycle operators may operate a motorcycle in Illinois for a period of not more than ninety days in any calendar year if they are licensed to operate a motorcycle in their home state.

Regulations governing use of motorcycles have been revised. Students should contact the Motor Vechicle Registration Office before operating a motorcycle in the University community.

Bicycles also must be registered with this office every year. No fee charged for such registration.

Operators of motor vehicles and bicycles must obey all Universit regulations, and state and municipal motor vehicle traffic laws and ord nances. This includes traffic lights, one-way streets, and other poste traffic signs.

Questions relating to vehicle regulations should be referred to the Offic of Motor Vehicle Registration, 101 North Mathews Avenue, Urban Illinois 61801.

Installment Plan for Payment of University Fees and Housing Charges

Students registered on the Urbana-Champaign campus are given th option of paying tuition, fees, and residence hall charges (in the case o single student housing only) on an installment basis. Tuition and fe charges for each of the first and second semesters are collected in four in stallments, the first payable at registration and the remaining in each of th following months. The advance deposit, if paid, is applied against the firs installment. If this results is overpayment, the remainder is applied agains subsequent installments. Summer session charges are payable one-half a registration and one-half during the following month. This plan does no apply to registration in extramural and correspondence courses. University housing for married students is contracted on an annual lease basis and payments are made by the month.

Students electing the installment plan for payment of tuition and fee are assessed a $2.00 service charge. An additional service charge of $2.00 i assessed in the case of the flight instruction fee of $550.00 per course and the glider instruction fee of $245.00 per course if paid on the installment basis There is no service charge for the payment of University housing account on the installment basis. Arrangements for payment on the installment plan are made with the Business Office during registration. An installment is considered delinquent on the first day of the month following the date payment is due. Penalties, including cancellation of registration, may be imposed on students who permit their accounts to become delinquent.

Refund of Fees

Cancellation. A continuing student who pays tuition and fees for any term and who subsequently cancels his registration prior to the first day of classes of that term is refunded the full amount of his payment.

Withdrawal. A student subject to tuition and/or fees who files clearance papers for withdrawal from the University during any semester, term, or summer session, for reasons other than military or other approved national defense service, receives a refund as listed below. (Special refund regulations govern withdrawals for active military or other approved national defense service.)

IN A SEMESTER, TWELVE-WEEK TERM, OR ELEVEN-WEEK LAW PROGRAM:

(1) During the first ten days of instruction in a semester or term, refund is made of the full amount of the tuition and fees assessed except for a nonrefundable charge of $38.00.[1] When the total assessment has been less than $38.00, the full amount of the assessment, if any, is nonrefundable.
(2) After the first ten days but within the first half of the semester or term, refund is made of one-half of the total amount of the assessed tuition and fees which remains after deduction of the nonrefundable $38.00.
(3) After the midpoint of the semester or term, no refund is allowed.

IN AN EIGHT-WEEK SUMMER SESSION OR A FIVE AND ONE-HALF WEEK SUMMER LAW PROGRAM:

(1) During the first five days of instruction in the summer session, refund is made of the full amount of the tuition and fees assessed except for a nonrefundable charge of $28.00.[1] When the total assessment has been less than this amount, the full amount of the assessment, if any, is nonrefundable.
(2) After the first five days but within the first half of the summer session, one-half of the amount assessed which remains after deduction of the above mentioned $28.00 is refunded.
(3) After the midpoint of the summer session, no refund is allowed.

Reduction of Program. A student who reduces his registration to a lower range receives a refund of the full amount of the difference in tuition and fees specified for such schedules provided the changes are made during the period designated for refund of full fees in case of withdrawal from the University. One-half of the above differences is refunded if the changes are made during the period for one-half refund in case of withdrawal from the University. Thereafter, no rebate is allowed.

[1] The nonrefundable charge includes the hospital-medical-surgical fee, if originally paid; the student who withdraws from the University continues to be covered by the insurance and McKinley Hospital service until the close of the semester, term, or session. (The amounts of the nonrefundable charge are subject to change.)

Fields of Instruction

Courses open to graduate students are of three types. Those numbered from 300 to 399 are open to advanced undergraduate and graduate students. Those numbered 400 and above are open to graduate students only. Those numbered 500 to 599 are open only to graduate students in certain professional programs.

All courses for graduate students require previous preparation. By consulting this catalog, or, in some cases with the instructor, a student may determine whether he has had the ncessary prerequisites for a particular course.

Courses in this catalog are listed alphabetically by departments. The offerings in each field are arranged numerically in groups, with headings to indicate the students for whom they are designed. The 400 series are listed first; courses in the 300 series follow. After the title of each course is a brief description of its content, the credit given, and the requirements for admission to the course.

A number of courses offer variable credit. At the 300 level, additional work in the nature of special reports, papers, or projects is required of a student who registers for the maximum credit shown. In each case, the student, with the help of his adviser, determines whether or not his schedule allows sufficient time to complete the work required for maximum credit.

At the 400 level, research, reading, and independent study courses provide variable credit; proportionate time devoted to a particular activity can thus be indicated on the student's record.

Unless otherwise specified, it can be assumed that a course is offered at least once during each calendar year. Courses offered only in the summer session are indicated by "S"; courses given in alternate years are indicated with the year of offering. A complete listing of courses for each term is contained in the Time Table, published about six weeks prior to the beginning of each term and available from the Graduate College, 330 Administration Building.

ACCOUNTANCY

The Department of Accountancy offers graduate work leading to the degrees of Master o Accounting Science and Doctor of Philosophy. For graduates of business schools with credi in appropriate undergraduate courses, the M.A.S. degree requirements can be completed i one year. For non-business graduates, the M.A.S. can be earned in two years. The Ph.D degree takes approximately two years of full-time study and research beyond the M.A.S.

The grade-point average required for admission to graduate study in accountancy is 4.0 Applications from students with a grade-point average between 3.75 and 4.0 are considere on an individual basis. All applicants, native or foreign, are required to take the Admissio Test for Graduate Study in Business. This test should be taken early enough to insure tha the results will be available to the department prior to action on admission.

Master of Accounting Science. All M.A.S. candidates take Accountancy 462, 481 and 594, and a graduate-level course in both economic theory and organization theory. N thesis is required, although the student may elect to write one. Courses in linear algebra operations research, and computer programming and applications must be taken, if such courses were not taken in prior academic work.

A candidate with undergraduate background in accounting is required to complete a least eight units of work, four of which must be in accountancy, for the M.A.S. degree. Such student should have completed an equivalent of the undergraduate curriculum at the Uni versity of Illinois at Urbana-Champaign, including twenty hours of undergraduate work i accounting, introductory courses in economic theory and the functional fields of business, tw courses in statistics, and courses in finite mathematics and calculus. He may take graduate level courses for credit to satisfy these requirements.

A student with little or no business and accounting background is required to complet sixteen units of work for the M.A.S. degree. Such a student takes Accountancy 501, 502, 503 and 504 during his first year. Depending upon his background, he also enrolls in courses i statistics, business economics, operations research, business organization, calculus and deci sion theory. A student who believes he already meets some of the requirements of the two-yea M.A.S. program is given the opportunity to substitute elective courses for areas in which he ca satisfactorily demonstrate his proficiency. In his second year, he follows the requirements fo all M.A.S. students, as described above.

Adequate provisions have been made for electives suited to the particular interests o both one-year and two-year M.A.S. students.

Doctor of Philosophy. A candidate for the Doctor of Philosophy degree must have hi admission approved by the departmental admissions committee which may require an ora or written examination.

The requirements for the Doctor of Philosophy degree include a master's degree; cours work equivalent to that required for the M.A.S. degree; credit in micro- and macro-economics a minor or minors of at least four units other than accountancy; at least eight units of accoun tancy, including Accountancy 483, or equivalent (not less than six of these eight units must b taken for graduate credit at the University of Illinois at Urbana-Champaign); and additiona units to bring the total to at least twenty-four, including the eight units allowed for a master' degree. Eight of the twenty-four must be doctoral dissertation units. The student's doctora program is determined in consultation with his faculty adviser. The student's tentative plan for the doctoral dissertation serve as a guidepost in planning the program.

In addition to the major and minor requirements above, the candidate must satisfy a non-business field requirement and must pass an oral and written preliminary examinatio and an oral final examination on his doctoral dissertation. In his preliminary examinations the candidate must demonstrate a thorough knowledge of accounting theory and of the area of accountancy in which he specialized, a general acquaintance with the subject matter and bibliography of other areas of accountancy, and proficiency in his minor fields and in the re quired areas of economic theory, quantitative methods, and organization theory.

More information concerning these programs can be found in the departmental pub lication, *Graduate Programs in Accountancy*. Requests for this publication and for other informa

tion should be addressed to the Head of the Department of Accountancy, 360 Commerce and Business Administration Building (West), Urbana, Illinois 61801.

CENTER FOR INTERNATIONAL EDUCATION AND RESEARCH IN ACCOUNTING

The Center for International Education and Research in Accounting is functionally and administratively a constituent part of the Department of Accountancy. The Center's objective is to foster the international development of education and research in the accounting discipline, to provide a base for the international exchange of ideas and materials, to carry out research programs of international interest, and to assist accounting faculty and able students from other countries to come to the University of Illinois for study and research in accountancy. The staff of the Center, composed of outstanding teachers and researchers from foreign countries, also conducts seminars and courses for graduate credit. Inquiries concerning the Center should be directed to: Professor V. K. Zimmerman, Director, Center for International Education and Research in Accounting, 320 Commerce and Business Administration Building (West), Urbana, Illinois 61801.

FACULTY

Professors: E. J. DeMaris (Head of Department), N. M. Bedford, G. D. Brighton, R. I. Dickey, C. F. Dunham, P. E. Fess, H. P. Holzer, Dorothy Litherland, R. K. Mautz, C. A. Moyer, K. W. Perry, H. M. Schoenfeld, D. H. Skadden, W. E. Thomas, N. D. Wakefield, V. K. Zimmerman.

Associate Professor: E. L. Elliott.

Assistant Professors: J. W. Deskins, J. C. McKeown, F. L. Neumann, L. S. Revsine, K. Sommer.

PROFESSIONAL COURSES

501. Accounting Analysis, I. Uses of account information; collection, processing, and communication of accounting information; measurement of assets, liabilities, equities, and income; accounting system design. ¾ unit. Deskins, McKeown.

502. Accounting Analysis, II. An in-depth study of accounting valuation processes and accounting income measurement; special reporting problems of multiple-entity organizations; accounting for nonprofit organizations. ¾ unit. Prerequisite: Accountancy 501 or equivalent. Bedford, McKeown.

503. Managerial Accounting. Introduction to management accounting as a part of a firm's information system, in terms of modern cost accounting and budgetary systems for planning and controlling business operations. 1 unit. Prerequisite: Credit or registration in Accountancy 501 or equivalent. Holzer.

504. Taxation and Auditing. Introduction to historical and conceptual material in specialized accounting areas of taxation and auditing. Emphasis centered on provisions of the tax law relevant to accounting measurement methods and on nature of evidence in auditing, auditing standards and techniques, and ethical constraints imposed on the auditor. 1 unit. Prerequisite: Accountancy 501, 503, or equivalent. Brighton, Neumann.

566. Accounting Problems of Industrial Management. A development of the role and importance of cost and revenue data in the process of enterprise administration. Attention is focused on the goals of the firm and the possible aid in achieving these goals that would come from properly conceived, prepared, and utilized cost and revenue data. For Master of Accounting Science and Master of Business Administration students only. 1 unit. Schoenfeld.

577. Professional Problems. Instruction as to types and methods of solution of professional problems in public accounting, including practice in analyzing and solving a wide variety of such problems. For Master of Accounting Science students only. 1 unit. Perry, Skadden.

594. Methods and Practices in Professional Research. Instruction in research methods materials, and techniques together with individual practice in conducting and reporting on specific professional research projects. For Master of Accounting Science student only. 1 unit. DESKINS, NEUMANN, REVSINE, ZIMMERMAN.

COURSES FOR GRADUATES

432. Accounting Under Different Social Systems. An inquiry into the ways accounting has been adapted to the needs of different social systems; the extent of its contribution its apparent limitations. Consideration is also given to the relationship between accounting and the growth and development of social systems. 1 unit. Prerequisite: Consent o instructor. DEMARIS.

441. State and Federal Accounting Theory. Advanced study in accounting and other fisca procedures of the federal government; state, county, and municipal governments; institutions. 1 unit.

455. Macro-Accounting. Same as Economics 425. An examination of the fundamental concepts underlying the attempts to measure the economic activities of macro-units; similarities and contrasts of accounting problems, theoretical and practical, of the business enterprise and of national or regional units in relationship to existing systems of accounting measurement; macro-accounting statements and analyses; usefulness of macro-accounting techniques and data in evaluating national and regional goals. 1 unit. Prerequisite: Intermediate macro-accounting theory or consent of instructor. ZIMMERMAN.

461. Administrative Accounting. Accounting as a tool for management; organization of accounting department, coordination of departmental operations, control of assets, control of operations, management audits, accounting aspects of coordinating the business with market conditions; cooperation with public accountants and government agencies, and social responsibilities. 1 unit. HOLZER, THOMAS.

462. Management Accounting. An examination of recent conceptual and analytical developments in the area of management accounting. The course includes a study of modern and relevant planning and control techniques and their underlying concepts as applied to the various functional areas within the firm. 1 unit. Prerequisite: An undergraduate course in management accounting. The student's background in statistics and mathematics should be equivalent to the undergraduate requirements of the University of Illinois College of Commerce and Business Administration in these areas. HOLZER, REVSINE, SOMMER.

466. Cost Accounting Theory and Analysis. A critical examination of cost accounting methods as to truth and expediency. 1 unit. DICKEY.

471. Accounting Reports. Form, contents, certificates, comments, consolidated statements, auditor's rights and responsibilities, published corporation reports. 1 unit. WAKEFIELD.

472. Auditing Standards and Techniques. A critical analysis of the techniques used in auditing; interrelation of audit standards, procedures, principles, and techniques; internal control as related to audit techniques; trends and developments in the accounting profession. 1 unit. MAUTZ, MOYER.

473. The Theory of Accounting System Design. Problems and procedures in connection with designing and installing accounting systems. 1 unit. THOMAS.

474. Income Tax Development. A theoretical and historical approach to the study of the development of federal income taxation, together with some research on tax cases and critical appraisal of the current law and proposals for its revision. 1 unit. BRIGHTON, SKADDEN.

475. Accounting Information System Simulation. An examination of the concepts and methodology of simulation, with particular emphasis on the information system of the firm. A simulation model is developed and used as a basis for deriving information

regarding system performance. 1 unit. Prerequisite: Mathematics through calculus, knowledge of computer programming, or consent of instructor.

481. **Concepts and Principles.** The fundamental structure of accounting theory is developed through the study of concepts characteristic of accounting and an examination of the literature dealing with the concise formulation of accounting principles. 1 unit. Bedford, Deskins, Mautz, Moyer.

483. **Income Determination.** A study of the pros and cons of various unsettled issues involved in the calculation and disclosure of enterprise periodic income. 1 unit. Bedford, Mautz, Neumann.

485. **Relationship of Accounting Theory to Philosophy, Science, and Other Disciplines.** An examination of the relationship of accounting theory to the developments, thoughts, and methods in the fundamental intellectual disciplines. 1 unit. Bedford.

489. **History of Accounting Theory.** An examination of the more important aspects of accounting theory under the impact of changing conditions over four centuries, with major emphasis on the later developments. 1 unit. Zimmermann.

493. **Special Research Problems.** Individual investigations or research projects selected by the students, subject to approval by the graduate adviser and the executive officer of the department. 1/4 to 2 units. Staff.

499. **Thesis Research.** Individual direction and guidance in writing theses, and seminar discussion of progress made. 0 to 4 units. Fess.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. **Advanced Accounting.** Reserves, sinking funds, actuarial methods, investments, partnerships, statements for special purposes, receiverships, consolidated balance sheets, foreign exchange. 3/4 unit. Prerequisite: Accountancy 166 and 108; an average of C or better in preceding courses in accountancy. Brighton, Dunham, Perry, Wakefield.

325. **Accounting System Design.** An introduction to the fundamentals of accounting system design. This includes the design and use of business papers, records, and reports; the functions of business machines in accounting systems; and personnel problems in accounting system design. 3/4 unit. Prerequisite: Computer Science 105 or equivalent; Accountancy 166.

341. **Governmental Accounting.** Accounts of institutions, municipalities, and state and federal governments; organization; procedure, budget, accounts and records, reports, audits. 1/2 unit. Prerequisite: Accountancy 108. Brighton, Dunham.

362. **Business Budgets and Accounting Control.** Procedures used in the preparation of business budgets and the principles underlying these procedures. A complete budget is prepared by the student for a typical manufacturing company. 3/4 unit. Prerequisite: Nine hours of accountancy, including Accountancy 166. Holzer, Schoenfeld, Thomas.

366. **Advanced Cost Accounting.** Advanced accounting for production management. Principles and methods of accounting for managerial control of costs of production through the use of standards. 1/2 unit. Prerequisite: Nine hours of accountancy, including Accountancy 166. Dickey, Holzer.

371. **Auditing.** Nature of audit evidence, basic audit techniques, audit practices and procedures, professional ethics, audit reports. 3/4 unit. Prerequisite: Accountancy 308. Fess, Mautz, Neumann.

372. **Auditing Problems and Cases.** Application of auditing principles in verification of financial statements; preparation of reports; case studies applicable to specific industries; current trends. 3/4 unit. Prerequisite: Accountancy 371. Fess, Moyer, Zimmermann.

374. **Advanced Income Tax Problems.** Practical and theoretical training in the more common and important provisions of the federal income tax, advanced problems, tax case research and preparation. 3/4 unit. Prerequisite: Accountancy 274 and 308. Brighton, Skadden.

377. Advanced Problems. Consolidated statements, foreign subsidiaries, insurance, estates, theory, general statements. 1 unit. Prerequisite: Credit or registration in Accountancy 371. Dunham, Fess, Perry.

378. Advanced Theory and Practice. Selected problems from C.P.A. examinations: analysis and revision of statements, partnerships, corporations, quasi-reorganizations, mergers, and others; theory auditing, ethics. 1 unit. Prerequisite: Accountancy 377. Perry, Skadden.

ADVERTISING

The Department of Advertising offers graduate work leading to the Master of Science in Advertising. For the program leading to the Doctor of Philosophy in Communications, see page 138.

Admission to graduate study in advertising requires completion of the requirements for a bachelor's degree in an institution of recognized standing. Furthermore, a grade-point average of at least 4.0 is normally required. Applications of students with grade-point averages below 4.0 are considered on an individual basis. All applicants are urged to take the Graduate Record Examination (GRE).

Requirements for the degree of Master of Science in Advertising include:

(1) A minimum of eight units (with thesis) or nine units (without thesis).

(2) A minimum of four units of advertising, or three units of advertising and one additional unit approved by the adviser. Candidates must select at least three units from Advertising 481, 482, 484, and 485. Advertising 381, 382, 383, 384, and 387, or the equivalent, are required. A basic course in statistical methods is prerequisite to Advertising 381 and 482.

(3) A minimum of two units of non-advertising courses.

(4) A thesis of one unit (in exceptional cases two units may be allowed); or in lieu of a thesis a minimum of nine units of course work.

(5) A minimum of four units of credit at the 400 level in addition to Advertising 499.

FACULTY

Professors: S. W. Dunn (Head of Department), N. Wedding.
Associate Professor: A. M. Barban.
Assistant Professors: J. W. Kitson, C. F. Steilen.

COURSES FOR GRADUATES

481. Advanced Advertising Principles. Same as Communications 481. Emphasis is placed on determination and understanding of the principles as related to the science, philosphy, and art of advertising. Students may not receive graduate credit for both Advertising 481 and 388. 1 unit. Wedding.

482. Research Methods in Advertising and Communications. Same as Communications 482. A treatment of basic research concepts and procedures in the social sciences with emphasis on advertising and communications. Both nonquantitative and quantitative methods are examined. Prerequisite: A basic course in statistical methods. 1 unit. Dunn.

484. Advertising and Consumer Behavior. An examination of consumer behavior as a means of shaping the communications message; use of the behavioral sciences in creative communication strategy. 1 unit. Barban.

485. Advertising Planning and Decision Making. An examination of the theoretical foundations of decision theory as they relate to planning and decision making in advertising; use of decision models in the development of strategies and tactics. 1 unit. Steilen.

490. Special Topics in Advertising. ½ or 1 unit. Prerequisite: Consent of head of department. STAFF.

499. Thesis Research. 1 to 2 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

309. Public Relations. Publicity methods and public relations; representation of business and other sponsors to the public and representation of the public to employers. Preparation of public relations units for the press and other media. ½ unit. Prerequisite: Consent of department.

381. Advertising Research Methods. Quantitative techniques and research methodology in advertising; philosophy of science, statistical methods, survey and experimental design, etc. Emphasis is on the problems of advertising research. ½ unit. Prerequisite: A basic course in statistical methods; Advertising 281. STEILEN.

382. Advertising Creative Strategy. Theory and practice of advertising message planning and creation for print and broacast media; use of consumer and market surveys, copy-testing methods, and advertising readership studies. ½ unit. Prerequisite: Advertising 281; consent of department. KITSON.

383. Advertising Media Policy and Strategy. Analysis of the various advertising media in terms of markets served and factors to consider in the selection of media. ½ unit. Prerequisite: Advertising 281; consent of department. BARBAN.

384. Advertising Campaigns. Planning and execution of an advertising campaign; market and consumer research; development and allocation of advertising budget, organization and functions of advertising agency, choice of advertising appeals; selection of media; preparation of advertisements—copy and layout. ½ unit. Prerequisite: Advertising 382 and 383; consent of department. KITSON.

387. Advertising and Promotion Management. Analysis of actual advertising situations and study of how such situations were or might have been met. Emphasis is given to management decision-making problems at the national level. ½ unit. Prerequisite: Advertising 281; consent of department. WEDDING.

388. Advertising in Contemporary Society. A study of advertising as an institution and its role in communications, society, our economy, and business. Students may not receive graduate credit for both Advertising 388 and 481. ½ unit. Prerequisite: Advertising 281; consent of department.

389. International Advertising and Promotion. The role of advertising and promotion in international communication and economic development; behavioral science approach to international communications strategy; comparative analysis of advertising and promotion systems. ½ unit. Prerequisite: Advertising 281; consent of department. DUNN.

390. Advanced Creative Strategy. Advanced work in application of behavioral sciences and creative process to planning and writing of advertisements. ½ unit. Prerequisite: Advertising 382; consent of department.

AERONAUTICAL AND ASTRONAUTICAL ENGINEERING

The Department of Aeronautical and Astronautical Engineering offers graduate programs leading to the Master of Science and Doctor of Philosophy. Study and research are planned to prepare graduates for fundamental and applied work in airplane, missile, and space flight engineering. Typical areas of concentration are aerodynamics, aeroelasticity, space mechanics, flight mechanics, propulsion, structural mechanics, and guidance and control.

The minimum grade-point average for admission to graduate study in aeronautical and astronautical engineering is 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

The prerequisite for graduate study in aeronautical and astronautical engineering normally is the equivalent of the undergraduate courses required at the University of Illinois for a bachelor's degree in aeronautical and astronautical engineering; however, graduates of curricula leading to degrees in other fields of engineering, the physical sciences, or mathematics may also be admitted to advanced study.

Candidates for the degree of Master of Science are required to have a minimum of eight units of graduate work, including a thesis.

Because of the wide range of interests in the field of aeronautical and astronautical engineering, there are no specific course requirements for a major in the program of study leading to the degree of Doctor of Philosophy. Each student plans his study program in consultation with a departmental adviser. Courses offered by departments other than aeronautical and astronautical engineering may be included in the major area of study when these courses are of particular value to the work which students desire to emphasize. The major and minor programs must meet with the approval of the head of the department.

Graduate students who desire to minor in aeronautical and astronautical engineering must have taken mathematics through the first course in differential equations and the undergraduate aeronautical and astronautical engineering courses, or their equivalents, which are prerequisites to study in the area of the minor work. Deviation from these requirements requires approval from the head of the department.

For information concerning applied mathematics, see page 292.

FACULTY

Professors: H. S. Stillwell (Head of Department), B. L. Hicks, H. H. Hilton, H. W. Knoebel, Y. K. M. Lin, R. W. McCoy, A. I. Ormsbee, S. N. Roscoe, R. A. Strehlow, S. M. Yen, A. R. Zak.

Associate Professors: H. O. Barthel, C. E. Bond, L. H. Sentman, K. R. Sivier.

COURSES FOR GRADUATES

411. Advanced Aerodynamics of Compressible Fluids. Advanced aerodynamic theory of compressible fluids in the subsonic and supersonic velocity ranges. 1 unit. Ormsbee.

414. Boundary Layer Theory. Theories of the boundary layer of a compressible fluid and their solutions, laminar and turbulent; boundary layer in hypersonic flow. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 213. Yen.

415. Wing Theory. Theoretical analysis of the aerodynamic characteristics of two- and three-dimensional wings and multiple body systems in subsonic and supersonic flow. 1 unit. Prerequisite: Mathematics 346 or equivalent. Ormsbee.

416. Hypersonic Aerodynamics. Discussion of high Mach number flows including the aerodynamic effects of dissociation and ionization. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 411. Ormbsee.

417. Fundamentals of Gas Kinetics. Fundamental concepts required to study gas theory: derivation of the Boltzmann equation from classical mechanics; reduced and truncated distribution functions and the BBGKY hierarchy; molecular collisions; flux vectors, equations of change; moment equations; summational invariants; H-theorem and Maxwellian distribution; inclusion of the effect of solid surfaces in kinetic theory; existence theory for the Boltzmann equation; iteration procedures; moment methods; Chapman-Enskog procedure; first and second approximations to the distribution function, the heat flux vector, and stress tensor. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 213. Sentman.

418. Theory of Rarefield Gas Flows. Application of kinetic theory to rarefied gas flow problems; free-molecule flow; near free-molecule flow; linearized problems; flows with

appreciable deviation from equilibrium. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 417 or Physics 362. YEN.

428. **Theory of Large Deformations in Nonlinear Continuous Media.** Fundamental concepts of large deformations in nonlinear elasticity and inelasticity with applications; generalized tensors, finite deformations, stress-strain relations in terms of strain energy functions, solutions of tension, shear and bending problems, finite plane strain, theory of successive approximations, fiber reinforced beams, plates and cylinders, thermodynamics of deformable media, stability considerations, constituent relations for inelasticity. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 326 or equivalent. HILTON.

429. **Theory of Linear and Nonlinear Viscoelasticity.** Fundamental concepts of viscoelasticity with applications. Elastic-viscoelastic analogies, creep and relaxation functions, thermo-mechanical reciprocity relations, variational principles, model fitting, shear center motion, thick-walled cylinders under pressure and inertia loads with material annihilation, sandwich plates, propagation of viscoelastic waves, vibration of bars, plates and shells, nonlinear elastic-viscoelastic analogy, properties of nonlinear viscoelastic stress-strain laws, creep rupture, torsion of nonlinear bars and shells. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 326 or consent of instructor. HILTON.

434. **Aerodynamic Heating.** Theory of convective aerodynamic heating in high-speed flow, laminar and turbulent flows; ablation, transpiration cooling, and mass transfer cooling; aerodynamic heating in hypersonic flow, real gas effects, effect of pressure interactions and vorticity interactions; heat transfer in rarefied gas flows. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 414 or equivalent. YEN.

438. **Fundamentals of Combustion.** Same as Mechanical Engineering 403. Fundamentals of kinetic theory, transport phenomena, chemical equilibria, and reaction kinetics; flames, their gross properties, structure, and gas dynamics including oscillatory and turbulent burning; solid and liquid propellant combustion; one-dimensional detonation theory including structure and initiation; three-dimensional and other complex detonation waves; supersonic burning. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 213 or Mechanical Engineering 305. STREHLOW.

452. **Stochastic Structural Dynamics.** Same as Theoretical and Applied Mechanics 417. Linear structural dynamics problems treated from a probabilistic point of view; axiomatic probability theory and random processes; the response of linear structures to random excitation; practical problems in aeronautical and astronautical engineering. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 255 or Theoretical and Applied Mechanics 412, or equivalent. LIN.

453. **Stochastic Processes in Engineering.** Same as Electrical Engineering 438 and Theoretical and Applied Mechanics 418. Supplementing Aeronautical and Astronautical Engineering 452, Electrical Engineering 434, or Theoretical and Applied Mechanics 417 for additional engineering application of stochastic processes. Theories of random pulses and continuous Markov processes and their applications to dynamic and control systems; parametric excitations and stability; nonlinear devices; topics related to system failures. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 452, Electrical Engineering 434, Theoretical and Applied Mechanics 417, or equivalent. LIN.

490. **Seminar.** Presentation by graduate students and staff of current topics in the fields of aeronautics. No credit. Prerequisite: Graduate standing in aeronautical and astronautical engineering. SENTMAN.

493. **Special Problems.** Theoretical and experimental investigations of problems in airplane, missile, and space flight engineering. 1 to 2 units. STAFF.

499. **Thesis Research.** Research in the various areas of the aeronautical and astronautical sciences. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

306. Foundations of Mechanics and Gravitational Theory. Same as Astronomy 306. Introduction to the dynamics of particles and of rigid bodies with special emphasis on elementary planetary motion, motion of a rocket, motion of long-range projectile relative to Earth, precession of Earth's axis, etc. 1 unit. Prerequisite: Mathematics 142 or 143. McVittie, Stillwell.

311. Aerodynamics of Compressible Fluids. Methods of solution of fluid flow problems in subsonic, transonic, and supersonic flight regimes. $\frac{3}{4}$ or 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 213.

313. Aerodynamics of Incompressible Fluids. Governing equations for incompressible flow; vorticity, circulation, Kelvin and Helmholtz's theorems; velocity potential and stream function; three-dimensional steady and nonsteady flows, d'Alembert's paradox, apparent mass; two-dimensional steady flows, complex potential and velocity, mapping of flows; 2-D airfoils, Joukowsky transformation and airfoils; thin airfoil theory. $\frac{3}{4}$ or 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 213 or equivalent, or consent of instructor.

314. Aerodynamic Heat Transfer. Thermal boundary layers; turbulent heat transfer; aerodynamic heating; radiative heat transfer. $\frac{3}{4}$ or 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 213.

316. Atmospheric Flight Performance. Aerodynamics of flight; lift and drag analysis; performance of propulsive systems; performance analysis of lifting and non-lifting vehicles. $\frac{3}{4}$ or 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 213 and 233, or consent of instructor.

317. Elements of Magnetohydrodynamics. Same as Astronomy 317. Equations of magnetohydrodynamics, single-fluid and multiple-fluid models, magnetic interaction parameters, magnetosonic waves, hydromagnetic shock waves, aligned-field and cross-field flows, theory of characteristics, MHD acceleration, generation, and propulsion. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 212 or consent of instructor. Bond.

326. Theory of Continuous Media. Introduction to the general theory of continuous media and its application to the theories of elasticity, fluid mechanics, and inelasticity. Stress and strain tensors and their invariants; nonlinear strain relations; nonlinear equilibrium conditions; the mechanism of deformation of single crystal and polycrystalline media; basic concepts of the structure of matter; thermodynamic considerations; equations of state and stress-strain relationships with applications. 1 unit. Prerequisite: Consent of instructor. Hilton.

327. Thermal Stresses and Creep Buckling. Structural effects of aerodynamic heating; analysis of thermal stresses in elastic, viscoelastic, and plastic media; effect of temperature dependent material properties on thermal stresses; analytical studies of creep buckling due to axial loads and heating of plastic and linear and nonlinear viscoelastic columns, plates, and shells; life expectancy of structures under elevated temperatures; minimum weight and probability of failure; applications to high-speed airplane, missile, and space vehicle structures. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 326 or consent of instructor. Zak.

333. Electric Propulsion. Elements of propulsion as applied to deep space missions; physics of ionized gases; plasmadynamics; electrothermal, electromagnetic, and electrostatic acceleration of gases to high velocity; high-impulse thruster design and performance; the resistojet, arcjet, ion engine, MPD arc, and plasma gun. 1 unit.

334. Rocket Propulsion and Rocketry. The basic principles of rocket propulsion and rocketry are treated. Propellants and their influence on design of rockets, internal and external ballistics, combustion processes, design of components, guidance problems, flight performance, and rocket testing are discussed in detail. $\frac{1}{2}$ unit. Prerequisite: First course in thermodynamics or consent of instructor. McCloy.

351. Aeroelasticity and Aeroinelasticity. Advanced fundamental treatment of aerodynamic and dynamic structural phenomena associated with flexible airplanes and missiles; divergence of linear and nonlinear elastic lifting surfaces; effect of elastic and inelastic deformations on lift distributions and stability; elastic flutter of straight and swept wings; equations of disturbed motion of elastic and inelastic aircraft; dynamic response to forces, gusts, and continuous atmospheric turbulence; creep divergence of lifting surfaces; flutter in the presence of creep; effect of temperature on inelastic divergence and flutter. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 255. ZAK.

391. Special Problems. Special problems relating to the theory, design, testing, operation, maintenance, or production of airframes or aircraft power plants. $\frac{1}{2}$ or 1 unit. Prerequisite: Consent of instructor. STAFF.

AGRICULTURAL ECONOMICS

(Including Rural Sociology)

Graduate students may take work in agricultural economics leading to the Master of Science and Doctor of Philosophy. Fields of specialization include farm management, land economics, agricultural prices and marketing, agricultural finance, agricultural policy, international economic development, consumption economics, agricultural law, and rural sociology.

Students who desire to secure degrees in agricultural economics must have completed a course of study equivalent to a baccalaureate degree which includes twelve hours of agricultural economics and economics.

Students who desire to specialize in rural sociology should have had a minimum of six hours of sociology.

The grade-point average required for admission to graduate study in agricultural economics is 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

A candidate for the Master of Science degree is required to register for at least two units of economics, including one unit of economic theory. For the Doctor of Philosophy degree, a candidate must complete a minimum of (1) three units in economics, including one unit each of micro and macro theory, both at the 400 level; (2) one 300- or 400-level course in each of two areas in agricultural economics in which preliminary examinations are not written; and (3) two and one-half units in quantitative methods and research methodology. Equivalent courses are accepted in fulfillment of these requirements, subject to Graduate College regulations.

For a Ph.D. minor in agricultural economics, two units in agricultural economics and/or rural sociology are required, one unit being at the 400 level, with the minor program to be planned under the guidance of a staff member appointed by the head of the Department of Agricultural Economics.

FACULTY

Professors: H. G. HALCROW (Head of Department), C. B. BAKER, G. K. BRINEGAR, E. E. BROADBENT, B. L. BROOKS, W. D. BUDDEMEIER, F. DOVRING, JEAN DUE, F. C. FLIEGEL, C. L. FOLSE, H. W. HANNAH, T. A. HIERONYMUS, J. M. HOLCOMB, J. A. HOPKIN, G. G. JUDGE, R. A. KELLY, N. G. P. KRAUSZ, A. G. MUELLER, R. J. MUTTI, F. J. REISS, R. R. RENNE, R. G. SPITZE, E. R. SWANSON, T. TAKAYAMA, W. N. THOMPSON, R. N. VAN ARSDALL, V. I. WEST, S. W. WILLIAMS, J. E. WILLS.

Associate Professors: D. E. ERICKSON, L. P. FETTIG, H. D. GUITHER, J. H. HERBST, L. D. HILL, R. A. HINTON, J. R. ROUSH, S. C. SCHMIDT, H. J. SCHWEITZER, J. T. SCOTT, D. G. SMITH, M. M. WAGNER.

Assistant Professors: J. W. GRUEBELE, R. W. HERDT, R. M. LEUTHOLD, W. D. SEITZ, J. C. VAN ES.

Agricultural Economics

COURSES FOR GRADUATES

401. International Comparative Agriculture. Agricultural and food problems of the world and of selected countries viewed in the world setting; resources and institutional factors affecting production; national and international policies and plans for developing agricultural production and improving levels of living. Emphasis is given to a comparative approach to agricultural development of countries on different economic levels. 1 unit. Dovring.

404. Economics of Agricultural Production. Evaluation of efficiency in the use of agricultural resources; production relationships within the farm; adaptation of the farm business to uncertainty; production relationships among farms; location of agricultural production. 1 unit. Prerequisite: Economics 200 or 300 and Agricultural Economics 341 or consent of instructor. Swanson.

405. Economic Policies and Programs Affecting Agriculture. Economic analysis of state, national, and international policies and programs, including proposed legislation having important bearing on the well-being of farm people. 1 unit. Prerequisite: One semester of graduate work or consent of instructor. Guither, Halcrow, Schmidt.

406. Research Methodology in Agricultural Economics. Methods of inquiry leading to information which is reliable and relevant to the solution of problems significant in the agricultural economy. 1 unit. Prerequisite: Economics 400 or 401, or a course of comparable level in the basic field related to the student's research. Baker.

425. Farm Management Principles. Analysis of farm business records; evaluation of measures of efficiency; planning the cropping system for increased income and control of erosion; use of economic information in fitting livestock to the farm plan; efficient use of labor and power; special research problems in farm organization. 1 unit. Scott.

436. Problems in Marketing Agricultural Products. Factors influencing growth of markets; methods of reducing costs and improving marketing processes; activities of government agencies; cooperative efforts. 1 unit. Brinegar, Hill.

441. Agricultural Statistics. Sources and methods of collection and analysis of prices and other agricultural statistics; trend fitting, linear and curvilinear multiple correlation, analysis of variance and sampling. 1 unit. Prerequisite: An elementary course in statistics. West.

442. Quantitative Analysis in Agricultural Economics. Application of techniques of quantitative analysis in agricultural economics; construction, estimation, and interpretation of sector, spatial, and input-output models for the agricultural economy. 1 unit. Prerequisite: Agricultural Economics 441, Economics 401, and Mathematics 315. Judge.

470. Seminar in Family and Consumption Economics. Same as Home Economics 470. Discussion of current topics and review of the literature in family and consumption economics. ½ or 1 unit. Prerequisite: Economics 102 or 108 and a course in statistics; Agricultural Economics 370 or consent of instructor. Dunsing.

491. Seminar and Special Topics. All graduate students majoring in agricultural economics must register in the noncredit section of this course. In addition, students may register for credit for individual research or group instruction on special topics under the supervision of one or more staff members. 0 to 2 units.

499. Thesis Research. Individual research under supervision of members of the graduate teaching staff in their respective fields. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Economics of Agricultural Development. The economics of agriculture and the relationships between agriculture and other sectors of the economy in developing nations; agricultural productivity and levels of living in the less developed areas of the world; studies of agricultural development in different world regions, including Africa, Asia, and Latin America. 3/4 or 1 unit. Prerequisite: Economics 103 or 108. Due, Herdt, Thompson.

302. Financing Agriculture. Capital and credit needs of farmers; agencies supplying credit; problems of borrowers and lenders. 3/4 or 1 unit. Prerequisite: Economics 102 or 103, or 108. Baker, Hopkin.

303. Agricultural Law. Relation of common law principles and statutory law to land tenure, farm tenancy, farm labor, farm management, taxation, and other problems involving agriculture. 3/4 or 1 unit. Hannah, Krausz.

305. Agricultural Policies and Programs. The problems of agriculture as an industry and an analysis of past and current federal and state governmental policies and programs affecting agriculture; objectives and development of policies; the use of economic concepts in evaluating possible future agricultural policies and programs; and forces in policy formation. Field trip; expense, $10.00. 3/4 or 1 unit. Prerequisite: Economics 108. Spitze.

312. Farm Appraisals. Same as Agronomy 312. Valuation methods and value bases of farm real estate. Includes legal aspects of appraisal work, appraisal theory and procedures, condemnation appraisal, characteristics of the farmland market, engineering and agronomic data for farm appraisals, and practice appraisals. Seven field trips; expense about $10.00 1 unit. Prerequisite: Agronomy 101 and Agricultural Economics 220 or equivalent. Reiss, Staff.

318. Land Economics. Physical, economic, and institutional factors that affect the role of land in economic life; population and resource requirements; principles of land utilization; returns from land; land value; property rights and tenure rights; social controls; rural and urban land development. 3/4 or 1 unit. Prerequisite: Consent of instructor. Dovring.

324. Farm Operation. Operating costs in farming, analysis of farm jobs, farm work simplification, selecting power units and equipment for economical operation. Field trips; estimated expense, $5.00. 3/4 or 1 unit. Prerequisite: Agricultural Economics 220. Hinton, Van Arsdall, Wills.

325. Advanced Farm Management. The functions of management; effects of goals and values on management decisions; use of economic analysis in farm production planning including resource allocation and valuation, and cost minimization. 3/4 or 1 unit. Prerequisite: Agricultural Economics 220. Mueller, Scott.

326. Professional Farm Management. Principles of farm management applied to the problems of those managing farms for others as a profession; development of the profession; relationships with clients and farm operators; division of inputs and returns between owner and operator; direct operation of farms with hired labor; case problems; business practices and procedures; professional ethics. Field trips to farms and professional farm management offices; estimated expense, $25.00. 3/4 or 1 unit. Prerequisite: Credit or registration in Agricultural Economics 324; Agricultural Economics 325. Holcomb, Smith.

331. Grain Marketing. Economic and marketing problems in grain; the utilization of grain; pricing arrangements for grain, especially future markets; inventory management, operational problems at country and interior points; factors affecting grain prices; seasonal variation in grain prices. Field trips; estimated expense, $10.00. 3/4 or 1 unit. Prerequisite: Agricultural Economics 230 or an elementary marketing course. Brooks, Hieronymus.

332. Livestock Marketing. Same as Animal Science 332. Economic principles applied to marketing livestock and livestock products from the standpoint of producers, processors, and distributors; theoretical basis for evaluating alternative market systems and functions; evaluation of changes in the industry affecting marketing decisions. Field trip; estimated expense, $15.00. 3/4 or 1 unit. Prerequisite: Economics 108; Agricultural Economics 230 or an elementary marketing course. BROADBENT.

334. Marketing of Dairy Products. Same as Dairy Science 334. Economic interrelationships of various dairy products; collective bargaining; federal milk orders, mark-up laws, marketing quotas, and other governmental regulations; lowering distribution costs; factors affecting demand and consumption; expanding markets for dairy products. Inspection trip; estimated expense, $5.00. 3/4 or 1 unit. Prerequisite: Agricultural Economics 230 or an elementary marketing course, or twelve hours of dairy science or dairy technology. GRUEBELE.

335. Economics of Food Distribution. Same as Horticulture 335. Analysis of (1) marketing structures and operations in the manufacture and wholesale and retail distribution of food; (2) effects of industry organization and governmental regulations on marketing functions and efficiency; (3) consumer demand for food. 3/4 or 1 unit. Prerequisite: Economics 108; Agricultural Economics 230 or an elementary marketing course. KELLY.

337. Economic History of American Agriculture. Same as Economics and History 337. The development of American agriculture from early colonial times to the present. Emphasis on regional development, evolution of methods and equipment, trends in marketing and credit, and the making of federal farm policy. 3/4 or 1 unit. Prerequisite: A college-level course in basic economics or American history. GUITHER.

341. Agricultural Economic Statistics. Graphic presentation, frequency distribution, and inference and probability, time series analysis, index numbers, analysis of variance, correlation, and simple and multiple regression as applied to agricultural economics. 3/4 or 1 unit. Prerequisite: Mathematics 111 or 112, or equivalent. SCOTT.

342. Agricultural Prices. A study of the factors affecting prices of agricultural products; long-time, cyclical, seasonal, and other price movements; sources of information relating to production and demand factors; government activities as they relate to prices of agricultural products and problems in price analysis and forecasting. 3/4 or 1 unit. Prerequisite; Economics 103 or 108. SCHMIDT.

352. Economic Development in Latin America. Same as Economics 352. A study of economic activity and the process of diversification and industrialization in Latin America, with comparative analysis of selected countries. 1/2 or one unit. Prerequisite: Economics 103 or 108, or consent of instructor. BECKETT.

353. Economic Development in India and Southeast Asia. Same as Economics 353. Analysis of plans and progress toward economic development in India and Southeast Asia; economic characteristics of the area and their significance for economic development. 1/2 or 1 unit. Prerequisite: Economics 103 or 108, or consent of instructor. CUMMINGS.

354. Economic Development of Tropical Africa. Same as Economics 354. Types of African economies and growth of the exchange economy; development of natural resources, industry, trade, finance, and education; analysis of economic integration, governmental planning, and development projects; demographic, land tenure, and institutional influences on development. 1/2 or 1 unit. Prerequisite: Economics 103 or 108, or consent of instructor. DUE.

370. Family Economics. Same as Home Economics 370. Economic welfare of American families in terms of cost of living, standard of living, income, and net worth. 1/2 or 1 unit. Prerequisite: Economics 102 or 108; a course in applied statistics. DUNSING.

Rural Sociology

COURSES FOR GRADUATES

407. Population Studies and Demographic Analysis. Same as Sociology 407. Nature and development of population theories; population growth and measures of fertility, reproduction, mortality, morbidity, and internal migration; indices, rates, and standardizations used in analyzing compositional characteristics. Methods in population projections; relationship of economic, sociological, and psychological factors to population changes. 1 unit. Prerequisite: Twelve hours of social science and introductory statistics, or major in sociology, or consent of instructor. FOLSE.

477. Seminar on Community Organization. Same as Sociology 477. Theories relating to the community concept and the analysis of community organization; the process of community change as applied to societies in various parts of the world. 1 unit. Prerequisite: Sociology 275 or consent of instructor. FLIEGEL, SCHWEITZER.

487. Special Problems in Rural Sociology. Same as Sociology 487. ½ or 1 unit. Prerequisite: One unit of graduate credit in sociology; consent of instructor. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

343. Social Change in Developing Areas. Same as Sociology 343. Description and analysis of recent social and cultural changes occurring in new nations and developing economies. Special attention is given to problems of traditional social structure undergoing modernization. Social factors in economic growth, caste and class, nation-building, urbanization and population composition, education, family and religion. ½ or 1 unit. Prerequisite: Sociology 100 or 151, or equivalent. JACOBS, KARSH.

AGRICULTURAL EDUCATION

This program leads to the Master of Science in Agricultural Education and is open only to students who have met the requirements for teaching agriculture. It has been planned as a fifth year of work for students who have completed the requirements of the four-year general agriculture curriculum with major for teachers of agricultural occupations, or its equivalent. Candidates must earn four units in agriculture, two units in education, and two units in electives. The two units in education must include Educational Psychology 311 and 312, and History and Philosophy of Education 304 and 305. The courses in agriculture and the electives must be selected with the approval of the student's adviser. The electives may be in agriculture, in education, or in exceptional cases, in other fields.

A minimum of four units must be taken in residence. A maximum of four of the required eight units may be earned in extramural courses offered by the University of Illinois; of these four units, no more than two units may be in technical agriculture and no more than two units may be in education.

In order to fulfill one of the objectives of this program, that of broad general training in technical agriculture at the graduate level, the agriculture courses and electives must be selected with the approval of the adviser. In general, agriculture courses are selected from at least three subject-matter departments with no more than three units from any department.

The minimum grade-point average for admission to graduate study in agricultural education is 3.5. See pages 20 to 24.

Advisers for candidates for this degree are Assistant Dean C. D. Smith, 104 Mumford Hall; Professor Paul E. Hemp, 357a Education Building; Professor Lloyd J. Phipps, 347 Education Building; and other members of the staff of the Division of Agricultural Education, College of Education.

AGRICULTURAL ENGINEERING

(Including Agricultural Mechanization)

The Department of Agricultural Engineering offers graduate work leading to the Master of Science and Doctor of Philosophy degrees with a major in agricultural engineering. The student may specialize in field power and machinery (soil dynamics, tillage and earthmoving, operations analysis, dynamics of particles and mechanisms, accelerated drying, and vehicle stability); soil and water mechanics (hydraulics of structures, agricultural hydrology, drainage, mechanics of erosion, and water resources planning); farm structures (structural analysis and design, environmental control, air contaminates, and waste disposal); or electric power and processing (system analysis for farmstead mechanization, crop processing, and physical properties of agricultural products).

The grade-point average required for admission to graduate study is 4.0 for the last sixty hours of undergraduate work; however, applications of those with averages below 4.0 but above 3.75 are reviewed individually by the departmental graduate committee and admission may be recommended if credentials are satisfactory.

Candidates for the master's degree must have the equivalent of the undergraduate curriculum at the University of Illinois.

Candidates for the Doctor of Philosophy must fulfill all the standard requirements of the Graduate College as noted on pages 37 to 39. The program provides for a major in agricultural engineering with a minor in other graduate departments of engineering, mathematics, physics, including soil physics, or other disciplines in the physical sciences.

Opportunity for independent study and research is an important part of both the Master of Science and the doctorate programs. Research opportunities are available in both the Agricultural and Engineering Experiment Stations. For the master's degree, a thesis involving an analytical or experimental investigation and satisfying about one-fourth of the credit for the program is normally required.

Inquiries concerning graduate work should be directed to Frank B. Lanham, Head of the Department, 245 Agricultural Engineering Building.

FACULTY

Professors: F. B. Lanham (Head of Department), H. H. Beaty, E. L. Hansen, R. C. Hay, D. R. Hunt, B. A. Jones, Jr., J. W. Matthews, E. F. Olver, J. A. Weber, R. R. Yoerger.

Associate Professors: B. J. Butler, J. O. Curtis, D. L. Day, R. F. Epenschied, W. D. Lembke, H. B. Puckett, G. C. Shove, J. C. Siemens.

Assistant Professors: G. E. Hall, D. L. Hoag, W. R. Nave.

Agricultural Engineering

COURSES FOR GRADUATES

400. Research Orientation. Discussion of the philosophy and methods of research, thesis preparation, and publication of research findings. No credit.

436. Dynamics of Farm Machine Elements. Advanced study of the dynamics of farm machine elements with specific reference to functional operation, stresses, and fatigue life. 1 unit. Prerequisite: Agricultural Engineering 236 and 336, or equivalent. Yoerger.

440. Design and Analysis of Biological Experiments. Same as Agronomy, Animal Science, Dairy Science, Food Science, Forestry, Horticulture, and Veterinary Medical Science 440. Statistical methods as tools for research, Principles of designing experiments and methods of analysis for various kinds of designs, including factorial experiments, are considered from the viewpoint of when and how to use them. $^3/_4$ unit. Prerequisite: Agricultural Engineering 340 or equivalent.

441. Advanced Design and Analysis of Biological Experiments. Same as Agronomy 441. Design and analysis of complex experiments. Confounded factorials, lattice designs.

and other incomplete-block experiments are considered from the viewpoint of their characteristics, methods of analysis, and usefulness in biological research. ½ unit. Prerequisite: Agricultural Engineering 440 or equivalent.

446. Dynamics of Tillage, Traction, and Earthmoving. Relationship of soil parameters to forces acting on tillage tools, earthmoving components, and traction devices; stress strain relationships in soil, failure patterns, and pulverization; speed effects, energy requirements, power trains, and model simulation. 1 unit. Prerequisite: Bachelor of Science degree in engineering or consent of instructor. WEBER.

490. Seminar. Presentation and discussion of current research and literature in agricultural engineering. ¼ unit.

496. Problems in Agricultural Engineering. Investigation and report on problems in farm machinery, farm power, rural electrification, soil and water control, rural housing and farm structures. 1 unit. Prerequisite: Consent of head of department. STAFF.

499. Thesis Research. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. Instrumentation and Measurements. Same as Mechanical Engineering 311. Accuracy, precision, and statistical consideration of measurement data; dynamics of measurement; displacement, velocity, acceleration, force, torque, pressure, and temperature measurements; mechanical impedance; measurements on fluids; instrumentations. ¾ or 1 unit. YOERGER.

336. Design of Agricultural Machinery. Determining machine requirements and specifications, design layout, effective use of materials and shapes, relation of design to problems. ¾ unit. Prerequisite: Mechanical Engineering 224; Agricultural Engineering 236. HUNT.

340. Introduction to Applied Statistics. Same as Agronomy, Animal Science, Dairy Science, Food Science, Forestry, Horticulture, and Veterinary Medical Science 340. Statistical methods involving relationships between populations and samples; collection, organization, and analysis of data; techniques in testing hypotheses with an introduction to regression, correlation, and analyses of variance limited to the completely randomized design and the randomized complete-block design. ¾ unit. Prerequisite: Mathematics 104 or 111 or 112, or equivalent.

346. Tractors and Prime Movers. Engineering aspects of design and application of tractors for farm, construction, and military use; thermodynamics of engines, turbines, and other power units, measurement of power and efficiencies, transmission of power, traction, stability, and hydraulic circuitry. ¾ unit. Prerequisite: Mechanical Engineering 209, Agricultural Engineering 146, or equivalent. WEBER.

356. Soil Conservation Structures. Hydrology, hydraulics, design, construction, and cost estimating of soil and water conservation structures; relationship of slopes, soils, crops, and practices in soil conservation and flood control. ¾ unit. Prerequisite: Theoretical and Applied Mechanics 235; Agricultural Engineering 277 or equivalent. LEMBKE.

357. Land Drainage. The design, construction, performance, and maintenance of surface, tile and open ditch drainage systems. ¾ unit. Prerequisite: Theoretical and Applied Mechanics 235. JONES.

376. Advanced Design of Farm Structures. Timber, steel, and concrete building design, with emphasis on structures for agricultural production. ¾ unit. Prerequisite: Civil Engineering 262; Agricultural Engineering 277 or equivalent. CURTIS.

387. Agricultural Process Engineering. Principles, design factors, equipment, and controls of systems for drying, referigerating, reducing, pelleting, blending, cleaning, sorting, and treating agricultural crops and products. ¾ unit. Prerequisite: Agricultural Engineering 286 or Chemical Engineering 363. SHOVE.

396. Special Problems. Individual investigation and report of any phase of agricultural

engineering approved by the department. 1/4 to 1 unit. Prerequisite: Senior standing in engineering. STAFF.

Agricultural Mechanization

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Special Problems. An agricultural problem with engineering implications is selected for study, investigation, and report, wherein a satisfactory solution does not require a background in engineering education. 1/4 to 1 unit. Prerequisite: Written consent of instructor and authorized departmental approval required prior to advance enrollment and registration. Specific approval of the associate dean in advance of registration is required for a second special problems course. STAFF.

331. Farm Machinery Technology. Application, functional operation, and management of tillage, planting, chemical application and harvesting machinery, incorporating current engineering, agronomic, and biological research results. For students presently in or preparing for teacher training or extension education. 3/4 unit. Prerequisite: Agricultural Mechanization 112 or 221. BUTLER.

361. Development and Function of Family Housing. Same as Home Economics 361. Study of principles and problem solutions in family housing; basic functions, plan patterns, types, materials, and structure; economic influences, costs, and adaptations to personal and public interest. 3/4 unit. HANSEN.

381. Electro-Mechanical Agricultural Systems. Application of electric power and mechanical equipment to livestock production, crop conditioning, and materials handling systems; for efficient use of time, power, and labor. Principles of planning material handling systems; requirements for environmental control in agricultural production; electric controls circuits; and factors affecting drying, cooling, and processing of crops. 3/4 unit. Prerequisite: Agricultural Mechanization 281 or graduate standing in agriculture. HALL.

AGRONOMY

The Department of Agronomy offers graduate work leading to the Master of Science and Doctor of Philosophy in Agronomy. The student may specialize in (1) crops: breeding and genetics, evolution, production, morphological development, physiology, plant chemistry, weeds and their control; (2) soils: biology, chemistry and biochemistry, fertility, genesis, morphology and classification, management, physical and colloidal chemistry, physical edaphology, physics; or (3) biometry.

The student must show promise of achievement in his chosen field, must have a grade point average of 3.75 or higher for the last sixty semester hours of work completed, and must be approved by the Department of Agronomy. For students having grade-point average below 4.0 but above 3.75, only those having unusually strong training in the basic sciences are considered for admission.

Adequate preparation for graduate work in soils includes courses in physics, chemistry, geology, microbiology, and mathematics; in crops, courses in botany, chemistry, genetics, and statistics; in biometry, courses in mathematics, statistics, and computer programming.

A candidate for the Master of Science must present an acceptable thesis, unless this requirement is waived by petition, and pass an oral examination.

A candidate for the Doctor of Philosophy is required to take at least four units of 300 or 400 level courses outside the Department of Agronomy.

FACULTY

Professors: M. D. Thorne (Head of Department), S. R. Aldrich, D. E. Alexander, A. H. Beavers, C. M. Brown (Associate Head of Department), A. W. Burger, J. M. DeWet, J. W. Dudley, E. B. Earley, J. B. Fehrenbacher, J. W. Gerdemann, J. E. Gieseking, H. H. Hadley, R. H. Hageman, J. B. Hanson, J. R. Harlan, C. N. Hittle, A. L. Hooker, J. A. Jackobs, R. W. Jugenheimer, E. L. Knake, L. T. Kurtz, J. R. Laughnan, E. R. Leng, S. W. Melsted, R. J. Miller, R. T. Odell, J. W. Pendleton, D. B. Peters, M. B. Russell, W. O. Scott, R. D. Seif, F. W. Slife, F. J. Stevenson, E. H. Tyner, L. F. Welch.

Associate Professors: R. L. Bernard, S. G. Carmer, R. L. Cooper, R. C. Hiltibran, R. L. Jones, D. A. Miller, R. J. Millington, R. W. Rinne, E. C. A. Runge, R. O. Weibel, C. M. Wilson, J. T. Woolley.

Assistant Professors: O. C. Braids, T. D. Hinesly, T. Hymowitz, R. J. Lambert, M. D. McGlamery, J. E. Molina, W. L. Ogren, E. B. Patterson, B. W. Ray, W. M. Walker, L. M. Wax, Evelyn J. Weber, J. M. Widholm.

COURSES FOR GRADUATES

400. Seminar. Discussions of current literature in crops and soils. Required of all graduate majors in agronomy. No credit. Staff.

402. The Chemistry of Soil Fertility. The chemistry of the essential plant nutrients in soils, their reactions and their quantitative relationship to plant growth. Lectures, discussion, and assigned reading. 1 unit. Prerequisite: Agronomy 101; Chemistry 122. Melsted.

403. Genesis, Morphology, and Classification of Soils. Historical review of soil genesis and classification; morphology and genesis of diagnostic soil horizons and features; soil genesis processes and reactions; classification of soils; characteristics, geography, and production potentials of major soil groups of the world. Lectures, discussions, and assigned readings. Offered in 1970–1971 and in alternate years. 1 unit. Prerequisite: Agronomy 301 or consent of instructor. Fehrenbacher.

405. Colloidal Chemistry of Soils. Soil components, their nature, and their influence on the physical, chemical, biological, and electrokinetic properties of soils. Lectures, discussions, and assigned reading. 1 unit. Prerequisite: Chemistry 340 and 341, or equivalent. Gieseking.

411. Soil Physics. The derivation and application of the fundamental physical principles and laws which govern the behavior of soils. Transport phenomena and physical characteristics of soils are emphasized. Lectures, discussions, and assigned readings. 1 unit. Prerequisite: One year of calculus.

412. Soil Organic Matter. Basic considerations in organic matter transformation; geochemistry of organic matter; nature and origin of humic substances; reactions of organic matter in soils and sediments. Lectures, discussions, and assigned readings. Offered in 1971–1972 and in alternate years. 1 unit. Prerequisite: Consent of instructor. Stevenson.

414. Physical Chemistry of Clays and Soils. Same as Mining Engineering and Ceramic Engineering 414. The application of physical chemical principles and concepts to surfaces and adsorption on surfaces. Silicate surfaces and water adsorption are emphasized. Offered in 1970-1971 and in alternate years. 1 unit. Prerequisite: Chemistry 340 and 341, or equivalent, or consent of instructor. R. J. Miller.

422. Pasture, Range, and Soil Conservation Research. Discussion and study of data and literature pertaining to pastures, range, and soil conservation; application of research methods to the evaluation of forage species in the management and utilization of pasture and range and to soil conservation. 1 unit. Prerequisite: Agronomy 121, 321, or 322. Jackobs.

423. Cytogenetic and Evolutionary Basis of Plant Breeding. Nature and origin of crop species; genetic and cytogenetic basis for developing special plant materials and the use of such materials in breeding programs. Emphasis on discontinuous variation. 1 unit. Prerequisite: Agronomy or Horticulture 323, or equivalent, or consent of instructor. HADLEY.

424. Mineral Nutrition of Plants. Same as Botany and Horticulture 424. A study of the uptake, transport, and metabolic utilization of mineral nutrients by plants. The scope of the course is to present the essentiality of various anions and cations in the light of metabolic activity and constituency in functional plant compounds. Major emphasis is placed on metabolic activity and function of the elements. 1 unit. Prerequisite: Botany 330 or consent of instructor. HAGEMAN.

429. The Evolution of Agricultural Economies. Same as Anthropology and Geography 429. The problems concerning the development of the several basic food crop economies are studied from the point of view of geographical environment, the available archaeological and ethnographic evidence, and from the point of view of agronomy and plant genetics. The regional emphasis varies from year to year. 1 unit. Prerequisite: Consent of instructor. C. S. ALEXANDER, STAFF.

436. Advanced Plant Physiology: Photosynthesis. Same as Botany 436. A lecture and laboratory course dealing with physiological, biochemical, and biophysical aspects of photosynthesis. 1 unit. Prerequisite: One year each of college biology, chemistry, and physics, or consent of instructor. GOVINDJEE, OGREN.

440. Design and Analysis of Biological Experiments. Same as Agricultural Engineering, Animal Science, Dairy Science, Food Science, Forestry, Horticulture, and Veterinary Medical Science 440. Statistical methods as tools for research. Principles of designing experiments and methods of analysis for various kinds of designs, including factorial experiments, are considered from the viewpoint of when and how to use them. $^3/_4$ unit. Prerequisite: Agronomy 340 or equivalent. CARMER, SEIF, WALKER.

441. Advanced Design and Analysis of Biological Experiments. Same as Agricultural Engineering 441. Design and analysis of complex experiments. Confounded factorials, lattice designs, and other incomplete-block experiments are considered from the viewpoint of their characteristics, methods of analysis, and usefulness in biological research. $^1/_2$ unit. Prerequisite: Agronomy 440 or equivalent. CARMER.

442. Environmental Plant Physiology. Same as Botany 442. A lecture course dealing with the interaction of plants and environment at the level of the whole organism, extending to the cell and the community. Heat and mass transfer, plant and soil potentials, and the effects of light on growth are emphasized. $^3/_4$ unit. Prerequisite: Chemistry 133, general physics, general or plant physiology, and consent of instructor. BOYER.

443. Environmental Plant Physiology Laboratory. Same as Botany 443. A laboratory course illustrating quantitative techniques for studying the response of whole plants to environment. Experiments are designed to illustrate methods of gas analysis and advanced techniques for measuring energy balance, potentials, and matter flow through plants. $^3/_4$ unit. Prerequisite: Chemistry 133, general physics, general or plant physiology, and consent of instructor; credit or registration in Botany 442. BOYER.

444. Quantitative Aspects of Plant Breeding. A study of the theoretical bases for plant breeding procedures with special emphasis on the relationship between type and source of genetic variability, mode of reproduction, and effectiveness of different selection procedures. 1 unit. Prerequisite: Agronomy 323 or equivalent; Agronomy 441 or equivalent. DUDLEY.

462. Origin of Variation in Plants. Same as Botany 462. A study of the principles of plant evolution. Theoretical and descriptive aspects of origin of variation, mode of speciation, role of hybridization, natural and artificial selection, and adaptation are discussed. 1 unit. Prerequisite: Consent of instructor. DEWET.

493. Advanced Studies in Agonomy. Directed and supervised detailed study of selected

problems or topics, 1/4 to 2 units. Prerequisite: Consent of instructor. Study may be in any one of the following fields:

(a) Soil Chemistry.
(b) Soil Fertility.
(c) Soil Physics.
(d) Soil Classification and Pedology.
(e) Soil Mineralogy.
(f) Soil Microbiology.
(g) Plant Breeding and Genetics.
(h) Plant Physiology.
(i) Weed Control.
(j) Crop Morphology.
(k) Crop Production and Ecology.
(l) Statistical Techniques and Data Processing.

499. Thesis Research. 0 to 4 units.
(a) Soils. Aldrich, Beavers, Fehrenbacher, Gieseking, Hinesly, Jones, Kurtz, Melsted, R. J. Miller, Millington, Molina, Odell, Peters, Runge, Stevenson, Tyner, Walker, Welch.
(b) Crops. Alexander, Bernard, Brown, Burger, Carmer, Cooper, DeWet, Dudley, Earley, Gerdemann, Hadley, Hageman, Hanson, Harlan, Hittle, Hooker, Jackobs, Knake, Lambert, Laughnan, Leng, D. A. Miller, Patterson, Pendleton, Rinne, Scott, Seif, Slife, Wax, Weber, Weibel, Widholm, Wilson, Woolley.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Advanced Special Problems. Individual problems in crops or soils. Graduate students majoring in agronomy do not receive graduate credit for this course. 1/4 to 2 units. Prerequisite: Consent of instructor. Staff.

301. Soil Survey, with Emphasis on Illinois Soils. Properties and methods used in distinguishing soils; characteristics and distribution of different soils in Illinois; the cause of these differences and their influence upon proper soil use and management. Laboratory work includes instruction in mapping soils and the use of soil maps, and field trips to examine representative soils. Estimated cost of field trips, $10.00. 3/4 unit. Prerequisite: Agronomy 101 or consent of instructor. Odell.

303. Soil Fertility and Fertilizers. Factors affecting the supply of available major, secondary, and minor elements in soils and their influence on crop production; evaluating fertilizer and lime needs; fertilizing manufacture, sources, and application methods. 3/4 unit. Prerequisite: Agronomy 101. Welsh.

304. Soil Management and Conservation. Application of principles of soil management to the solution of land use and conservation problems; influence of soil characteristics on drainage, erosion control, cropping intensity, water management, and land use planning. 3/4 unit. Prerequisite: Agronomy 101. Oschwald.

305. Biochemical Processes in Soil and Water Environments. Metabolic processes leading to chemical transformations in soil and water environments; implications for soil fertility and environmental pollution. 3/4 unit. Prerequisite: Microbiology 110; Chemistry 102. Molina, Stevenson.

306. The Dynamics of Soil Development. Soils as complex dynamic bodies are related to various disciplines important to their understanding, such as geology, geomorphology, chemistry, and ecology; the importance of having an overall model to help in understanding soils is discussed. Two field trips. 3/4 unit. Prerequisite: Agronomy 101, Chemistry 102, or consent of instructor. Runge.

307. Soil Chemistry. A course emphasizing the inorganic reactions involved in soil development and plant nutrition in soils. Topics discussed include colloid systems, properties of

water, ion exchange equilibria, plant nutrient forms, and methods of analyses. ¾ unit. Prerequisite: Agronomy 101; Chemistry 102. MELSTED.

308. The Physics of the Plant Environment. The physics of transport processes in the soil and aerial environment of plants; exchanges of energy and gases in crop canopies and the retention and flow of water, gases, solutes, and heat in soils. 1 unit. Prerequisite: Physics 102; one semester of calculus.

312. Farm Appraisals. Same as Agricultural Economics 312. Valuation methods and value bases of farm real estate. Includes legal aspects of appraisal work, apparisal theory and procedures, condemnation appraisal, characteristics of the farmland market, engineering and agronomic data for farm appraisals, and practice appraisals. Seven field trips; cost about $7.00. 1 unit. Prerequisite: Agronomy 101 and Agricultural Economics 220, or equivalent. REISS.

313. Soil Mineral Analysis. Specialized analytical procedures for determinations of soil minerals and their properties; mineralogy of soils and relationships to soil genesis and fertility. Offered in 1970-1971 and in alternate years. 1 unit. Prerequisite: Agronomy 101 or consent of instructor. BEAVER, JONES.

321. Ecological and Physiological Factors Affecting Crop Production. The environmental requirements of crop plants and their physiological bases; the physical nature of the environment and its interaction with crop plants; and the distribution and yield of selected crops as a function of environment. 1 unit. Prerequisite: Botany 100 or 101; Chemistry 102 or 133. STAFF.

322. Forage Crops and Pastures. Forages, their plant characteristics, ecology and production, grasslands of farm and range as related to animal production and soil conservation. ¾ unit. Prerequisite: Agronomy 121. D. A. MILLER.

323. Principles of Plant Breeding. Same as Horticulture 323. Genetic and cytological variation in crop plants, the production and control of such variation in developing varieties and hybrids, and the maintenance of high quality seed stocks. Field trips; estimated cost, $5.00. 1 unit. Prerequisite: Agronomy 110 or equivalent; Botany 100. LAMBERT, D. A. MILLER.

326. Weeds and Their Control. Weeds, their introduction, methods of dissemination, reproduction, and control; a characterization of the common weeds of the Midwest. ¾ unit. Prerequisite: Agronomy 121. MCGLAMERY.

340. An Introduction to Applied Statistics. Same as Agricultural Engineering, Animal Science, Dairy Science, Food Science, Forestry, Horticulture, and Veterinary Medical Science 340. Statistical methods involving relationships between populations and samples; collection, organization, and analysis of data; techniques in testing hypotheses with an introduction to regression, correlation, and analyses of variance limited to the completely randomized design and the randomized complete-block design. ¾ unit. Prerequisite: Mathematics 104 or 111 or 112, or equivalent. SEIF.

350. Crops and Man. Interpretations of the role of crop plants in the development of cultures and civilizations. Crops are described primarily in terms of their origins, evolution, and influences on man's technology, art, and religion, and his social and political institutions. Field trip; estimated cost, $10.00. ¾ unit. HARLAN.

365. Digital Computer Methods for Statistical Data Processing. Same as Computer Science 365. A study of methods for efficient utilization of high-speed equipment in processing of statistical data. Emphasis is on principles of application of computing equipment to the solution of statistical problems. Numerous examples are given and actual problem solution by the student is accomplished. 1 unit. Prerequisite: Computer Science 101, 103, 107, or 121, and a course in statistics or statistical methods or equivalent, or consent of instructor. CARMER.

377. Diseases of Field Crops. Same as Plant Pathology 377. A study of the symptoms of the major field crop diseases, life histories of causal organisms, and methods of control. Offered in 1971-1972 and in alternate years. ¾ unit. Prerequisite: Plant Pathology 204 or equivalent. HOOKER.

ANIMAL SCIENCE

The Department of Animal Science offers graduate work leading to the Master of Science and Doctor of Philosophy in Animal Science. Research may be pursued in the following areas of specialization: (1) population and immunogenetics, (2) physiology of reproduction including endocrinology, (3) animal nutrition, (4) nutritional biochemistry, (5) ecology, (6) meat science and muscle biology, and (7) world animal agriculture. In addition, a student who expects to terminate the graduate program at the master's level may pursue work in animal production. Beef cattle, horses, poultry, sheep, swine, and a wide variety of laboratory animals are available for use in conducting research in the above areas.

The minimum grade-point average for admission to graduate study in animal science is 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

Courses in biological and physical sciences and mathematics are essential preparation for graduate work in any specialized area of animal science. Candidates specializing in the areas of animal nutrition or nutritional biochemistry must have training equivalent to one five-hour course each in quantitative analysis and organic chemistry; a course in physical chemistry also is strongly recommended. Candidates specializing in meat science should have undergraduate training in meat evaluation, use, and/or processing, and in microbiology. Students lacking adequate background to register in graduate courses at the University of Illinois are expected to remove course deficiencies during the first year of graduate study.

FACULTY

Professors: D. E. Becker (Head of Department), O. G. Bentley, D. J. Bray, P. J. Dziuk, R. M. Forbes, U. S. Garrigus, E. E. Hatfield, A. H. Jensen, J. Kastelic, G. A. Leveille, S. P. Mistry, A. V. Nalbandov, H. W. Norton, B. A. Rasmusen.

Associate Professor: B. G. Harmon.

Assistant Professors: W. W. Albert, D. H. Baker, C. D. O. Foster, F. C. Hinds, D. E. Johnson, F. N. Owens, R. M. Robson, J. R. Romans.

COURSES FOR GRADUATES

400. Presentation of Experimental Results. Preparation of technical material for oral or written presentation. 1/4 unit. Dziuk.

401. Animal Bionomics. A lecture and discussion course pertaining to the ecological factors affecting physiological, functional, behavioral, and productive response of domestic animals. 1/2 unit. Prerequisite: Consent of instructor. Curtis.

402. Principles of Sheep and Wool Production. Basic considerations in sheep and wool production and lamb feeding. Reports of research. 1/2 unit. Prerequisite: Consent of instructor. Garrigus.

403. Techniques and Topics in Animal Research. Discussion and study of literature pertaining to animal research; application of experimental technics; special topics; review of research in current problem areas. 1/2 unit. Prerequisite: Consent of instructor. Becker.

404. Concepts in Nonruminant Nutrition. A review of current literature in nonruminant nutrition. 1/2 unit. Prerequisite: Consent of instructor. Baker.

406. Physiology of Reproduction. Same as Zoology 406. Comparative physiology of reproduction and endocrinology of domestic and laboratory animals; fertility and sterility. Lectures and laboratory. 1 unit. Nalbandov.

407. Laboratory Methods in Animal Genetics. 1/2 to 1 unit. Combined credit in Animal Science 407 and 408 may not exceed two units. Prerequisite: Consent of instructor. Norton.

408. Laboratory Methods in Physiology of Reproduction. Same as Zoology 408. $^1/_2$ to 1 unit. Combined credit in Animal Science 407 and 408 may not exceed two units. Prerequisite: Consent of instructor. NALBANDOV.

410. Research Methods in Animal Science. Intended to give students training and experience in various techniques used in research with poultry, sheep, swine, beef cattle, and meats. $^1/_4$ to 1 unit; may be repeated for credit not to exceed a total of one unit. Prerequisite: Consent of instructor. STAFF.

415. Advanced Animal Genetics. Same as Dairy Science 415. Genetic theory, analysis of animal breeding problems, genetic results of selection, and different systems of breeding. 1 unit. Prerequisite: Animal Science 305 or equivalent. NORTON.

416. Population Genetics and Animal Breeding. Same as Dairy Science 416. The mathematical theory of population genetics and its application to the improvement of farm animals; results of different systems of mating and the expected gains from different methods of selection. 1 unit. Prerequisite: Animal Science 110 or equivalent. A knowledge of elementary algebra is essential. TOUCHBERRY.

412. Advanced Endocrinology. Same as Dairy Science, Physiology, and Zoology 412. Seminar, lectures, student reports, and discussions of recent advances in endocrinology. $^1/_2$ unit; may be repated for credit not to exceed a total of two units. Prerequisite: Consent of instructor. GORSKI, NALBANDOV.

420. Comparative Nutrition. Physiological aspects of the nutrition of higher animals and man, including the digestion, utilization, and function of nutrients, and the effects of dietary deficiencies. 1 unit. Prerequisite: Chemistry 350 and 355. FORBES.

421. Topics in Nutritional Biochemistry. Biochemical aspects of the nutrition of higher animals and man, with emphasis on the function and metabolism of nutrients. 1 unit. Prerequisite: Animal Science 420. LEVEILLE, MISTRY.

440. Design and Analysis of Biological Experiments. Same as Agricultural Engineering, Agronomy, Dairy Science, Food Science, Forestry, Horticulture, and Veterinary Medical Science 440. Statistical methods as tools for research. Principles of designing experiments and methods of analysis for various kinds of designs, including factorial experiments, are considered from the viewpoint of when and how to use them. $^3/_4$ unit. Prerequisite: Animal Science 340 or equivalent. SEIF.

463. Radioisotopes in Biological Research: Principles and Practice. See Veterinary Medical Science 463. $^3/_4$ unit. Prerequisite: Quantitative chemistry; one year each of mathematics, physics, biology, and/or consent of instructor. TWARDOCK.

481. Animal Biochemical Laboratory Techniques. Same as Dairy Science 481. Theory and application of biochemical laboratory techniques to research in the animal-oriented biological sciences. Isolation, characterization, and analysis of biological compounds including enzymes, metabolic intermediates, and cellular components; determination of metabolic pathways and processes. 1 unit. Prerequisite: Chemistry 350 and 355; consent of instructor. LARSON.

496. The Use of Carbon-14 in Labeling Techniques. Same as Chemistry 496. A comprehensive study of the chemistry of carbon-14. The laboratory work deals with vacuum-line manipulations and synthesis, degradation, and assay of radioactive carbon compounds. $^3/_4$ or 1 unit. Prerequisite: Chemistry 336, 337, and 338, or equivalent; consent of instructor. CONRAD, NYSTROM.

499. Thesis Research. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Beef Production. The principles of feeding and management of beef cattle; financial aspects of beef production; diseases, parasites, and breeding difficulties of beef cattle. Lectures, demonstrations, and discussions. $^3/_4$ unit. Prerequisite: Animal Science 221 or equivalent. HATFIELD, JOHNSON.

302. Sheep Production. The sheep and wool industries; principles and practices of various phases of production. 3/4 unit. Prerequisite: Animal Science 221 or equivalent. GARRIGUS.

303. Pork Production. The place of the swine enterprise on the farm; selecting, breeding, feeding, managing, and marketing of swine for greatest profit. 3/4 unit. Prerequisite: Animal Science 221 or equivalent. HARMON, JENSEN.

304. Poultry Management. The application of science and technology in solving the breeding, feeding, housing, and various management problems encountered in commercial egg and poultry meat production. 3/4 unit. Prerequisite: Animal Science 221 or 325, or equivalent. BRAY.

305. Genetics and Animal Improvement. Same as Dairy Science 305. The principles of heredity and their application to the problems of animal improvement. 3/4 unit; S, 1/2 unit. Prerequisite: Animal Science 110 or equivalent. RASMUSEN, TOUCHBERRY.

320. Nutrition and Digestive Physiology of Ruminants. Same as Dairy Science 320. The physiology and microbiology of digestion in the ruminant and biochemical pathways of utilization of the absorbed nutrients for productive purposes. 3/4 unit. Prerequisite: Animal Science or Dairy Science 221. DAVIS, HINDS.

325. Principles of Animal Nutrition. Principles of animal nutrition and their application to veterinary practice. This course is designed primarily for students in veterinary medicine. 1 1/4 units. Credit is not allowed for Animal Science 221 and 325. Prerequisite: Chemistry 354 or 350 and 355. OWENS.

330. Reproduction and Artificial Insemination of Farm Animals. Same as Dairy Science 330. The anatomy and physiology of reproduction in farm animals, the principles of artificial insemination, and the factors affecting conception in natural and artificial breeding. 3/4 unit; S, 1/2 unit. Prerequisite: Zoology 104 and either Dairy Science 100 or Animal Science 100. GRAVES.

332. Livestock Marketing. Same as Agricultural Economics 332. Economic principles applied to marketing livestock and livestock products from the standpoint of producers, processors, and distributors; theoretical basis for evaluating alternative marketing systems and functions; evaluation of changes in the industry affecting marketing decisions. Field trip; estimated cost, $10.00. 3/4 or 1 unit. Prerequisite: Economics 108; Agricultural Economics 230 or an elementary marketing course. BROADBENT.

340. An Introduction to Applied Statistics. Same as Agricultural Engineering, Agronomy, Dairy Science, Food Science, Forestry, Horticulture, and Veterinary Medical Science 340. Statistical methods involving relationships between populations and samples; collection, organization, and analysis of data; techniques in testing hypotheses with an introduction to regression, correlation, and analyses of variance limited to the completely randomized design and the randomized complete-block design. 3/4 unit. Prerequisite: Mathematics 104 or 111, or 112, or equivalent. SEIF.

341. Human Evolution, II. Same as Anthropology 341. The principles of human genetics, anthropological aspects of race and race formation, and hereditary and environmental factors in the biological variation of modern man. Additional work required of graduate students registering for one unit of credit in this course. 1/2 or 1 unit. Prerequisite: Anthropology 102 or Zoology 101 or 104, or consent of instructor. RASMUSEN.

346. Ethology. Same as Zoology 346. The behavior of animals as interpreted through comparative studies and experimentation. Lecture, 1/2 unit; lecture and laboratory, 1 unit. Prerequisite: One year of 300-level courses in zoology, physiology, or psychology; consent of instructor for laboratory enrollment. BANKS.

350. World Animal Agriculture. Same as Dairy Science 350. Survey and interpretations of the role of animal agriculture in various cultures of the world with particular references to underdeveloped countries of the world. The importance of improved animal agriculture for land resource utilization and for meeting food and animal power needs of people is discussed. 3/4 unit. Prerequisite: Consent of instructor. BROWN, KASTELIC.

ANTHROPOLOGY

The Department of Anthropology offers graduate work leading to the Master of Arts and Doctor of Philosophy. Courses and guided study provide a broad coverage of anthropology with concentrations in ethnology of Latin America, aboriginal North America, Northern Eurasia, Japan, Indonesia, Southeast and South Asia, and Africa south of the Sahara; culture historical and archaeological methods; culture change and modernization in complex societies; urban anthropology; human ecology; structural and formal analysis of cultural systems; ethnolinguistics; and ethnomusicology. Relevant courses are offered in other fields, e.g., linguistics, history, sociology, geography, agricultural economics, life sciences, and preventive medicine. The department also supports student attendance at field schools and study in mathematics, languages, and other areas at summer institutes.

Original research in the field, laboratory, and library is financially supported by the department. Opportunities include participation in faculty research projects, attendance at University of Illinois archaeological and ethnological field schools held every summer, and independent graduate student research in the United States and abroad. For work on campus, the library and computer resources at the University of Illinois are outstanding.

Applicants for admission as first-year graduate students are required to have a grade-point average of 4.0 for the last sixty hours of undergraduate training. Exceptions may be made by a special committee for those applicants with a grade-point average between 3.5 and 4.0, particularly if the student displays substantial evidence of having acquired special skills or of having had significant experience relevant to anthropology. A student who does not have an undergraduate major in anthropology or its equivalent may be permitted to register for graduate courses, but will be required to make up any deficiencies.

A detailed statement of requirements for higher degrees and additional information about departmental programs and policies is available on request.

A graduate student must demonstrate ability to use, for scholarly purposes other than the exigencies of field investigations, either one foreign language at a high level of proficiency or two at an ordinary level; the nature of the capacity to be tested and the language or languages will be chosen by the student's departmental advisory committee. The results of such tests will not be required to be shown on the student's official transcript; hence, the tests will be administered within the department or, in the case of a language which none of its faculty controls, by arrangements made by the department with qualified persons.

With the approval of the adviser and the department, a candidate may satisfy the minor requirement by taking courses within the department. Approval is given only in those cases in which a subfield, such as biological anthropology or anthropological linguistics, constitutes an essential part of the candidate's overall program.

FACULTY

Professors: E. M. Bruner (Head of Department), J. B. Casagrande, D. W. Lathrap, F. K. Lehman, O. Lewis, J. C. Mc.Gregor, B. Nettl, D. W. Plath, D. B. Shimkin.

Associate Professors: C. E. Cunningham, H. A. Gould, R. T. Zuidema.

Assistant Professors: D. Butterworth, G. Gibbon, C. Keller, L. Rosen, H. M. Ross, J. F. Yegerlehner.

COURSES FOR GRADUATES

409. Field Methods in Linguistics. Same as Linguistics 309. The recording and analysis of a spoken language with a native speaker of that language as an informant. ½ or 1 unit. Prerequisite: Linguistics 300 or 301, or consent of instructor. Lehman, Yegerlehner.

410. Advanced Field Methods in Linguistics. Same as Linguistics 310. Advanced analysis of a spoken language with a native speaker of that language as an informant. ½ or 1 unit. Prerequisite: Anthropology 309 or equivalent. Lehman, Yegerlehner.

429. The Evolution of Agricultural Economies. Same as Agronomy and Geography 429. The problems concerning the development of the several basic food crop economies are studied from the point of view of geographical environment, the available archaeological and ethnographic evidence, and from the point of view of agronomy and plant genetics. The regional emphasis varies from year to year. 1 unit. Prerequisite: Consent of instructor. LATHRAP, STAFF.

440. Problems in Physical Anthropology. A seminar designed to involve students in the theoretical and methodological approaches to problem areas in physical anthropology. 1 unit. May be repeated for additional credit. Prerequisite: Anthropology 340; consent of instructor.

450. Seminar in Anthropology. Analysis of selected topics of special interest in anthropology. 1 unit. Students may reregister in this course up to a total of two units. STAFF.

451. Social Structure. This course is intended to acquaint the student with the descriptive techniques and methods of structural and functional analysis currently employed by social anthropologists in the study of primitive social groups and their methods of operation. 1 unit. Prerequisite: Consent of instructor. STAFF.

452. Research Problems in Archaeology. Seminar oriented to current research problems in archaeology, designed to acquaint students with theoretical and methodological aspects of particular problems, and to develop a critical perspective of archaeological research. Course may be repeated for additional credit. 1 unit. Prerequisite: Consent of instructor. MC.GREGOR.

453. The Formal Analysis of Kinship Systems. A survey of a variety of the world's systems of kinship, marriage, and family organization. Concentration on the distinctive properties of kinship systems as a species of social structure, on the formal apparatus for describing and understanding them and their functions, and on the theory of kinship that arises from the use of such formal apparatus. $\frac{1}{2}$ to 1 unit. Prerequisite: Consent of instructor. LEHMAN.

460. Theories and Methods in Anthropology. A seminar course identifying, investigating, and evaluating the various theories and trends, as well as methods employed by anthropologists. 1 unit. CASAGRANDE.

463. Seminar on Field Methods and Research Designs in Cultural Anthropology. Critical examination of field methods and research designs as reflected in selected studies covering the past seventy years, ranging from early missionary reports to those of contemporary field workers. An effort is made to discern major trends in methodology. Community studies and comparative studies on both the tribal and peasant levels are examined. 1 unit. Prerequisite: Consent of instructor. STAFF.

489. Readings in Anthropology. Individual guidance in intensive readings in the literature of one or more subdivisions of the field of anthropology, selected in consultation with the adviser in accordance with the needs and interest of the student. $\frac{1}{2}$ or 1 unit. Prerequisite: One semester of graduate work in anthropology; consent of adviser. STAFF.

490. Individual Topics in Anthropology. Supervised individual investigation or study of a topic not covered by regular courses. The topic selected by the student and the proposed plan of study are approved by the adviser and the staff member who supervises the work. 1 to 4 units. Prerequisite: Consent of instructor. STAFF.

499. Thesis Research. Preparation of theses. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Introduction to Linguistics. Same as Linguistics 300. An introduction to the science of descriptive linguistics. $\frac{1}{2}$ unit. Prerequisite: Fulfillment of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. STAFF.

307. Introduction to Mathematical Linguistics. Same as Linguistics 307. Principles of set theory, logic and formal systems, group theory, and automata theory; introduction to the formal theory of grammars. 1 unit. Prerequisite: Linguistics 300.

315. Area Studies in Ethnomusicology. Same as Music 317. A seminar devoted to intensive study in the music of one specific culture, e.g., Japan, China, Indonesia, India, the Near East, Africa and New World Negro, European and American folk cultures, American Indian. ½ unit. Prerequisite: Senior standing in music or consent of instructor. NETTL.

316. Introduction to Music of the World's Cultures. Same as Music 316. An introduction to non-Western and folk music, to the role of music in the world's societies, and to the methods of collecting and studying music in non-literate, folk, and Asian high cultures. For students outside the School of Music. ½ unit. Prerequisite: Anthropology 101 or 103, or consent of instructor. NETTL.

317. Languages of the World. Same as Linguistics 317. A survey of the main language families of the world from both genetic and typological points of view, with special reference to the theory of syntactic descriptions. ½ or 1 unit. Prerequisite: Linguistics 300 or consent of instructor. YEGERLEHNER.

320. Political Anthropology. The comparative and analytic study of the political systems of representative non-Western peoples. Attention is also paid to the transformations of native political institutions as consequences of colonialism and political modernization. ½ or 1 unit. Prerequisite: Anthropology 101 or 103, or consent of instructor. STAFF.

321. Primitive Social Organization. Describes how pre-literate non-Western societies are organized. Introduces techniques and theories used to investigate social organization. Considers how social organization relates to the natural environment and other aspects of human activity, and briefly, the processes of social change. Designed to prepare students specializing in social anthropology for advanced courses and seminars and as a survey of the field for students going into other disciplines. 1 unit. Prerequisite: Anthropology 101 or 103, or consent of instructor.

330. Processes of Culture Change. The impact of modern cultures on native peoples, comparative study of the mechanisms underlying the transition to modernity in the new nations, and the psychological and structural aspects of acculturation and urbanization. ½ or 1 unit. Prerequisite: Anthropology 101 or 103, or consent of instructor. BRUNER.

331. Aboriginal North America. The course deals with three major topics: (1) the nature and structure of aboriginal North America as a cultural province and its ecological base; (2) distinctive and common features of American Indian cultures; (3) responses to the stresses of white contact. Selected type cultures and their adaptations to varying ecological situations are examined in detail. ½ or 1 unit. Prerequisite: Anthropology 260. SHIMKIN.

332. Native Cultures of South America (non-Andean). A survey of South American cultures east of the Andes at the time of Western contact, and of the subsequent development of modern Indian cultures in the non-Andean regions. 1 unit. Prerequisite: Anthropology 260 or consent of instructor.

333. Native Cultures of South America (Andean). A survey of Andean cultures at the time of the Spanish conquest, of their subsequent history, and of modern Indian culture in the Andean countries. Sequel to Anthropology 332, but may be taken independently. 1 unit. Prerequisite: Anthropology 260 and 332, or consent of instructor.

340. Human Evolution, I. The principles of evolution, and a survey of the evolution of man and his progenitors to the Paleolithic. ½ or 1 unit. Prerequisite: Anthropology 101 or 102, or consent of instructor.

341. Human Evolution, II. Same as Animal Science 341. The principles of human genetics, anthropological aspects of race and race formation, and hereditary and environmental factors in the biological variation of modern man. Additional work required of graduate students registering for one unit of credit in this course. ½ or 1 unit. Prerequisite: Anthropology 101 or 102, or Zoology 101 or 104, or consent of instructor.

343. Introduction to Primate Morpology and Behavior. A survey of primate social behavior and the classification, morphology, and distribution of living and extinct species. Emphasis is placed on interrelationships with aspects of anthropological study. ½ or 1 unit. Prerequisite: Anthropology 340, or Zoology 101 or 104, or consent of instructor.

348. The Prehistory of Africa. The study of cultural development in Africa from the appearance of Hominids to the time of European domination. 1 unit. Prerequisite: Anthropology 220 or consent of instructor. KELLER.

349. South American Culture History, I. An examination of the factors influencing the initial peopling of South America, the spread and diversification of hunting and gathering economies, and the development and spread of the Tropical Forest cultural pattern. 1 unit. Prerequisite: Anthropology 220 or consent of instructor. LATHRAP.

350. South American Culture History, II. An examination of the factors leading to the rise of civilization in the Central Andes, including the evolution of agricultural systems, the elaboration of technology, and emergence of extensive and complex political units. 1 unit. Prerequisite: Anthropology 220 or consent of instructor. LATHRAP.

351. Archaeological Surveying: Techniques and Applications. Familiarization with methods used in the location and recording of archaeological sites, including techniques of mapping especially adapted to the needs of archaeology. Attention is also given to means of presenting results and interpreting data derived from this work. The course involves work both in the field and in the laboratory. 1 unit. Prerequisite: Anthropology 220 or equivalent, or consent of instructor. STAFF.

352. Precolumbian Civilizations of Mesoamerica. The major civilizations of Mexico and Guatemala are studied. Emphasis is placed on the growth and ramification of the several major cultural traditions and on the kinds of evidence which are available as a basis for the study of the growth of political units and their interaction. ½ or 1 unit. Prerequisite: Anthropology 220 or equivalent, or consent of instructor. LATHRAP.

353. Southwestern Archaeology. A detailed study of one archaeological unit in the United States, covering the three broad cultures with regional variations considered chronologically and stressing interrelationships of the various cultures. ½ or 1 unit. Prerequisite: Anthropology 220 or equivalent, or consent of instructor. MC.GREGOR, STAFF.

354. Field Techniques in Archaeology. Participation in archaeological excavation; techniques, methods, and procedures discussed and practiced in actual working conditions. S; 1 unit. Credit may be received twice if the areas or problems concerned are different. Prerequisite: Anthropology 101, or 102 and 103, or consent of instructor. STAFF.

355. Laboratory Techniques and Problems in Archaeology. Laboratory work in the field; studying, evaluating, and writing final reports on preceding field work. S; 1 unit. Credit may be received twice if the areas or problems concerned are different. Prerequisite: Anthropology 101, or 102 and 103, or consent of instructor. STAFF.

356. Physical Anthropology. The aims and methods of physical anthropology, both osteology and somatology, with emphasis on the human skeleton. 1 unit. Prerequisite: Anthropology 101, or 102 and 103, or consent of instructor. MC.GREGOR.

357. Midwestern Prehistory. A detailed study of the midwestern archaeological area covering the broad cultures with regional variations considered chronologically and stressing their interrelationships. ½ or 1 unit. Prerequisite: Anthropology 220 or equivalent, or consent of instructor. MC.GREGOR.

358. Prehistory of the Old World. An examination of Old World prehistory showing developments and relationships between various cultural traditions and histories from the earliest times. ½ or 1 unit. Prerequisite: Anthropology 220 or consent of instructor. KELLER.

359. The Mesolithic and the Origins of Food Production in the Old World. Continuation Anthropology 358. Designed to give students an introduction to the postglacial

hunting communities of Europe from around 8000 B.C. to the origins of food production, and to the domestication of animals in Europe, the Near East, and the Mediterranean basin. 1 unit. Prerequisite: Anthropology 220; consent of instructor.

360. Peoples of Oceania. A survey of the groups inhabiting the islands of the Pacific, including Australia. ½ or 1 unit. Prerequisite: Anthropology 101, or 102 and 103, or consent of instructor. Ross.

361. Peoples and Cultures of Mexico and Guatemala. A survey of the people and cultures of Middle America with special emphasis upon Mexico and Guatemala. This course begins by placing Middle America geographically, historically, and culturally within the broader Latin-American scene. The countries are first viewed as a whole and then selected ethnographic studies of specific communities are considered for comparative purposes. The Caribbean is not studied. ½ or 1 unit. Prerequisite: Anthropology 101, or 102 and 103, or consent of instructor. BUTTERWORTH.

363. Religion in Primitive Society. An introduction to the study of magic and religion in nonliterate societies. The course considers theories of the origin and function of magic and religion and an analysis of magic and religion in representative primitive societies. ½ or 1 unit. Prerequisite: Anthropology 101 or 103, or consent of instructor. Ross.

364. Field Work in Cultural Anthropology. Supervised participation in field research. Technique and procedures are discussed and practiced under actual working conditions. S; 1 unit. Credit may be received twice if the areas or problems involved are different. Prerequisite: Anthropology 101, or 102 and 103; speaking knowledge of the language of the area concerned; registration in Anthropology 365; consent of instructor. STAFF.

365. Analysis of Field Data in Cultural Anthropology. Evaluation, organization, and write-up of field data. S; 1 unit. Credit may be received twice if the areas or problems involved are different. Prerequisite: Anthropology 101, or 102 and 103; speaking knowledge of the language of the area concerned; consent of instructor. STAFF.

366. Peoples of Southeast Asia and Indonesia. The culture, history, economy, social system, political organization, and character structure of the peoples of Indonesia, Malaya, and the Philippines. Attention also is paid to contemporary economic and political problems of the newly independent nations seen from an anthropological perspective. ½ or 1 unit. Prerequisite: Anthropology 101, or 102 and 103, or consent of instructor. LEHMAN.

367. Peoples and Cultures of Africa. A survey of the cultures of Africa with particular emphasis on the ecological and historical development of culture types and the behavior associated with them. ½ or 1 unit. Prerequisite: Anthropology 101, or 102 and 103, or consent of instructor. STAFF.

368. Peoples and Cultures of India. A description and analysis of the social, economic, and religious life of the tribal and peasant peoples of contemporary India, considered against the background of Indian geography, population, language distribution, the caste system, and highlights of Indian cultural development. ½ or 1 unit. Prerequisite: Anthropology 101, or 102 and 103, or consent of instructor. GOULD.

369. Introduction to Human Ecology. Same as Geography, Health Education, Physiology, Psychology, Sociology, Veterinary Medical Science, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations, and physiological, psychological, and sociological adjustments to environment, regulation of population, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology; one year of anthropology, geography, geology, or sociology. SHIMKIN, STAFF.

370. Language, Culture, and Society. Same as Communications and Linguistics 370. An examination of the social and cultural functions of language, with particular emphasis on the application of linguistic methods and findings to selected problems in the social sciences. ½ or 1 unit. BRUKMAN.

371. Culture and Personality. A cross-cultural comparative analysis and evaluation of current theories of culture and personality formation. The course is concerned with the socio-cultural matrix in which personality develops, as well as with the application of personality concepts, especially those derived from psychoanalytic theory, to the study of primitive and modern society. ½ or 1 unit. Prerequisite: An introductory course in anthropology, sociology, or psychology, or consent of instructor. BRUNER.

372. The Anthropological Study of Art. A review of the anthropological approach to art with emphasis on structural analysis and the relationship of the artist to his culture. Problems of stylistic development are considered within the framework of cultural dynamics, and a survey of the major art style areas outside the Western tradition and the Orient is included. ½ or 1 unit. Prerequisite: Three hours of anthropology or consent of instructor. LATHRAP.

373. Human Development in Cross-Cultural Perspective. Same as Psychology 373. The comparative analysis of recurrent problems inherent in the biosocial nature of man, particularly as these are reflected in stages of the life cycle from birth through death. Attention is also given to the cross-cultural study of other selected topics such as illness and health, deviancy, and the handling of aggression. Use is made of materials available on the campus in the Human Relations Area Files. ½ or 1 unit. Prerequisite: Six hours of anthropology, sociology, or psychology, or consent of instructor.

374. Problems in Human Ecology. Same as Geography, Health Education, Physiology, Psychology, Sociology, and Veterinary Medical Science 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multidisciplinary studies of selected current problems. 1 unit. Prerequisite: Anthropology, Geography, Health Education, Physiology, Sociology, or Zoology 369. STAFF.

375. Peoples and Cultures of the Near and Middle East. A general survey of the region, including North Africa, with special emphasis on the interrelations of ecology, tribal structure, urban-tribal relations, and the local adaptations of Islamic religion and culture. Consideration also given to the social bases of contemporary political, economic, and legal problems in the region. ½ or 1 unit. Prerequisite: Anthropology 101 or 103, or consent of instructor.

377. Regional Topics in African Anthropology. Covers select sociocultural and historical topics of a separate region of Africa (e.g., East, West, Central, South, or North Africa) each time course is taught. Research paper. May be taken a second time only when different region is emphasized. 1 unit. Prerequisite: Consent of instructor. STAFF.

380. Applied Anthropology. The contributions of anthropology to modern problems such as the direction and execution of technical assistance programs in nonindustrialized areas of the world, and other cross-cultural contacts involving problems of administration, economic development, and the introduction of new practices and techniques. Designed to be of particular value to those students who expect to carry on technical or professional work among peoples of different cultures in foreign areas or in the United States. ½ or 1 unit. Prerequisite: Six hours of anthropology or sociology, or consent of instructor.

381. Russian Culture History and Ethnology. Same as Geography 381. An historical and structural analysis of the development of Russian culture, especially the peasant traditions, from Danubian to contemporary times. ½ or 1 unit. SHIMKIN.

382. Siberian Culture History and Ethnology. Same as Geography 382. An ecological analysis of historic and present-day Siberian cultures, with comparisons to Arctic America. ½ or 1 unit. SHIMKIN.

383. Cultures of Modern East Asia. Human life in the cultural setting of East Asia since the early nineteenth century. This course centers upon problems of adapting traditions and institutions to the needs of modern industrial civilization; geographical focus varies. 1 unit. Prerequisite: An introductory course in anthropology or East Asian history, or consent of instructor. PLATH.

384. Traditional Chinese Social Organization. A descriptive analysis of pre-modern Chinese culture and society with emphasis on domestic organization, rural and urban social structure, local government, and folk religion. Field studies in modern Taiwan and Hong Kong, of the overseas Chinese, and on the mainland used to exemplify particular aspects of Chinese life. 1 unit. Prerequisite: Anthropology 101 or 103, or consent of instructor.

385. The Anthropology of Education. Same as History and Philosophy of Education 385. Introduction to the contribution of anthropology to the cross-cultural study of education; includes illustrative material from representative cultures ranging from primitive social groups to present-day national states; emphasis is on education as a cultural process in relation to culture change and cultural development. ½ to 1 unit. Prerequisite: A course in anthropology or sociology, or consent of instructor.

ARABIC

See descriptions and course listings under Linguistics, page 281.

ARCHITECTURE

(Including Architectural Engineering)

The Department of Architecture offers graduate work leading to the Master of Architecture and Master of Science in Architectural Engineering. Fields of specialization are architectural and urban design (programs in advanced design; housing; industrialized buildings; theory, methodology, and criticism); advanced structural theory and design; architectural administration and building construction; history of architecture.

The prerequisite for graduate study in architecture is a bachelor's degree in architecture equivalent in scope and standards to that of the University of Illinois. The minimum grade-point average for admission to graduate study in architecture is 3.75. Applicants with averages below 3.75 but above 3.5 are considered on an individual basis. Applications from students expecting to register for courses in architectural or urban design must be accompanied by a portfolio of their work in these areas.

Students are expected to follow one of the recommended area programs or to plan an individual program in consultation with a faculty adviser. A minimum of eight units is required for the master's degree. Minimum residence period is two semesters. However, inadequacies in previous preparation, duties required for graduate assistantships, or other circumstances may extend the period of residence.

Details about the graduate program may be obtained by writing Graduate Programs, Department of Architecture, University of Illinois, Urbana, Illinois 61801.

FACULTY

Professors: J. H. Swing (Head of Department), J. S. Baker, I. J. Brightbill, G. T. Clayton, P. H. Coy, W. I. Creese, W. Eng, H. L. Hornbeak, R. A. Jones, R. D. Katz, A. K. Laing, W. H. Lewis, R. P. Link, C. B. Looker, A. Notaras, W. J. O'Connell, J. G. Replinger, I. Schousboe, R. J. Smith, S. J. Y. Tang, C. A. Winkelhake, H. C. Young.

Associate Professors: V. V. Cafourek, G. Exline, E. M. Farnham, G. Francescato, S. T. Lanford, L. A. Leffers, C. T. Marfort, F. D. Moyer.

Assistant Professor: J. E. Simon.

COURSES FOR GRADUATES

421. Environmental Control. Same as Mechanical Engineering 421. Design of environmental systems for buildings. Integration of mechanical, structural, and architectural

demands, in lectures and through a semester design project. 1 unit. Prerequisite: Undergraduate courses in heat transfer and fluid mechanics. TANG.

431. Advanced Theory of Architecture. A review of principles of architecture and urban design; factors in programming architectural requirements; design development; analysis and criticism. ½ unit. Prerequisite: Consent of instructor. FRANCESCATO.

432. Seminar in Architectural Design. The analysis and criticism of selected buildings. Individual reports and discussion. ½ unit. Prerequisite: Architecture 431 or consent of instructor. FRANCESCATO.

435. Advanced Architectural Design. Advanced study of space relationships and other elements of architectural design from urban scale to that of individual buildings, including the integration of structural, mechanical, and interior design. Joint studies in urban design with graduate students in urban planning and landscape architecture. ½ to 2 units. Prerequisite: Bachelor's degree in architecture (general option) or consent of instructor. FRANCESCATO, KATZ, REPLINGER.

452. Advanced Theory and Design of Steel Structures. Theory and design in bending, buckling, torsion, and combined stresses in beams and columns. Study in design and behavior of connections; composite constructions; light gauge steel construction analysis. Design and economy of simple and complex building frames. 1 unit. Prerequisite: Architecture 348 or consent of instructor. SCHOUSBOE.

454. Advanced Structural Design in Reinforced Concrete. Critical review of the methods and specifications involved in the design and behavior for flexure, shear, bond, and anchorage; slab-beam-girder, ribbed joist, two-way and flat-slab floor construction; columns and footings; torsion; plastic theory of design; economy and continuity in building design. 1 unit. Prerequisite: Architecture 358 or consent of instructor. TANG.

456. Matrix Methods of Structural Analysis. Use of matrix mathematics and digital computers in the analysis of indeterminate structures by the displacement and force methods. 1 unit. Prerequisite: Computer Science 101, Architecture 347; or consent of instructor. HORNBEAK.

481. Architectural Practice and the Construction Industry. Analysis of the construction industry and identification of those factors adversely affecting its development. Characteristics of, and relationships among, such components as architectural and engineering services, labor, contractors, manufacturers, building economics, governmental agencies, and research and testing agencies. Experts from these fields are invited to lead discussions on current problems and their solutions, on procedures adversely affecting the industry, and on current and needed areas of research. ½ unit. Prerequisite: Consent of instructor. LEWIS.

491. Special Problems in Architectural Administration and Building Construction. Individual or group research on approved subjects. ½ to 2 units. Prerequisite: Credit or registration in Architecture 481. LEWIS, STAFF.

493. Special Problems in Structural Theory and Design. Individual or group investigation and study in architectural engineering application. Research in economy and design in correlation with architectural, mechanical, and structural requirements. Options: foundation design; prestressed concrete design; plastic design in steel; structural planning; wood construction; architectural research laboratory. ½ to 4 units. Prerequisite: Consent of instructor. TANG, STAFF.

494. Special Problems in Architectural Design. Individual or group investigation of building types, theoretical problems, and other aspects of architecture. Options: design studio; building systems; architecture as a discipline; special research. ½ to 2 units. Prerequisite: Architecture 435 or consent of instructor. FRANCESCATO, KATZ, REPLINGER, VISITING CRITICS.

496. Special Problems in Architectural History. Individual investigation of the work of particular architects, specific buildings, or the architecture of periods or regions; com-

parative studies; aesthetic problems. ½ to 2 units. Prerequisite: Twelve hours of architectural history or consent of instructor. LAING, STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Independent Studies in Urban Design. The individual study of selected topics involving the history, design, and function of significant European cities. ¾ unit. Prerequisite: One year of history of architecture or history of art; consent of instructor.

310. Ancient Classical Architecture. The development of architecture and urban design in the ancient Greek world and the Roman Empire. ¾ unit. Prerequisite: Architecture 211 and 212, or Art 111 and 112, or consent of instructor.

311. Early Medieval Architecture. The architecture and urban design of the Byzantine Empire, Slavic states, Islam, and Western Europe from the early Christian to the Gothic era. ¾ unit. Prerequisite: Architecture 211 and 212, or Art 111 and 112, or consent of instructor.

312. Gothic Architecture. The development of architecture and urban design in Europe from the end of the Romanesque period to the Renaissance. ¾ unit. Prerequisite: Architecture 211 and 212, or Art 111 and 112, or consent of instructor.

313. Italian Renaissance and Baroque Architecture. The development of architecture, urban design, and garden art in Italy from the early fifteenth century to the late eighteenth century. ¾ unit. Prerequisite: Architecture 211 and 212, or Art 111 and 112, or consent of instructor.

314. French Architecture, 1500 to 1800. The development of architecture, urban design, and landscape architecture in France from the early sixteenth century to the late eighteenth century; French influence in the rest of Europe. ¾ unit. Prerequisite: Architecture 211 and 212, or Art 111 and 112, or consent of instructor.

315. English and American Architecture. Major architectural developments in Great Britain in the sixteenth, seventeenth, and eighteenth centuries; regional building traditions; sources and development of colonial architecture in America. ¾ unit. Prerequisite: Architecture 211 and 212, or Art 111 and 112, or consent of instructor.

316. Architecture of the Nineteenth and Twentieth Centuries. The development of architecture and urban design in Europe and the Americas from 1800 to the present with special consideration given to the influence of technology and urban conditions. ¾ unit. Prerequisite: Architecture 211 and 212, or Art 111 and 112, or consent of instructor.

317. The Development of Contemporary Architectural Thought. An examination of the philosophy of significant architectural writers and architects in relation to their projects and executed work. Those studied include Wright, Gropius, Le Corbusier, Mies van der Rohe, Ruskin, Pugin, Blondel, Laugier, Lodoli, Palladio, Alberti, and Vitruvius. ¾ unit. Prerequisite: Architecture 211 and 212, or Art 111 and 112, and consent of instructor.

337. Architectural Design. Continued study of architectural design emphasizing (a) complex site development and composition, and (b) definitive design and refinement of detail for one of the plan components. Preparation of senior thesis program. 2 units. Prerequisite: Architecture 236.

338. Architectural Design. Individual research and comprehensive design solution of a selected architectural project, with special emphasis on site development, integration of structures; mechanical equipment, illumination, and acoustics. 2 units. Prerequisite: Architecture 337.

344. Design Development and Construction Documents. Continued design development and integration of architectural, structural, mechanical, and electrical work for a previously designed student project; application of building codes, production planning

and preparation of general construction working drawings and specifications. No graduate credit. Prerequisite: Architecture 242 and 257; registration in Architecture 337 for general option students, or consent of instructor.

347. Theory of Structures. Advanced problems in the analysis of statically determinate structures; general theories and methods of analysis of statically indeterminate structures; relationships between analysis and design of building frames. 1½ units. Prerequisite: Architecture 257; Mathematics 142.

348. Advanced Structures. Advanced topics on design of structural members and connection. Analysis and design of continuous structures, rigid frames, and tall buildings. 1½ units. Prerequisite: Architecture 347; credit or registration in Architecture 358.

358. Advanced Reinforced Concrete. Reinforced concrete building design. 1 unit. Prerequisite: Architecture 247; credit or registration in Architecture 348.

379. Urban Housing. A study of housing needs, comparative means of financing, comparative building types and costs, and contemporary examples of public and private housing in Europe and the United States. ½ unit. Prerequisite: Consent of instructor.

ART

The Department of Art offers graduate work leading to the degrees listed below.

For admission, an applicant must be a graduate of an accredited college or university with at least a bachelor's degree and with a grade-point average of 3.5 or above; he must be accepted by the graduate committee of the Department of Art after examination of his transcripts, as well as examples of his work if his major is to be in a creative field. Students expecting to major in art education must have (or be eligible for) a teaching certificate in their field. Under ordinary circumstances, applicants are expected to have completed an undergraduate program similar to that which leads to the bachelor's degree as established at this University, with a major, or related studies acceptable to the advisers, in the field to be pursued in graduate study.

The minimum residence period is two years for the Master of Fine Arts and one year for the Master of Arts. However, duties relating to graduate assistantships and thesis requirements (in art history) will correspondingly extend the period of residence. When pertinent, the graduate committee may extend the student's residence, increase the unit or course requirements, or recommend the student's discontinuance of his degree program.

Complete descriptions of offerings and admission requirements for all degrees, and instructions for applying for admission and grants may be had by writing for application forms and the brochure, *Graduate Programs in Art*, to Warren F. Doolittle, Chairman of Graduate Programs in Art, Department of Art, 140 Fine and Applied Arts Building.

Master of Fine Arts with Design Major (Graphic Design or Industrial Design). Students must complete all the following courses for a minimum of sixteen units: Art 491, one to three units; Art 493, one unit; Art 467 or 477, six to ten units; art history (selected from the group Art 301 through 328), three-fourths unit to one and one-half units; electives or interdisciplinary subjects as determined in consultation with the adviser, two to six units. A thesis is required.

Master of Fine Arts with Painting and Printmaking Major. Students must complete all the following courses for a minimum of sixteen units: Art 491, one to three units; Art 493, one unit; Art 495, two to eight units; Art 497, two to eight units; art history (two courses selected from the group Art 301 through 328), one and one-half units; electives (art electives, art history, and/or other courses approved by the adviser), two to six units. A thesis exhibition is required.

Master of Fine Arts with Sculpture Major. Students must complete all the following courses for a minimum of sixteen units: Art 491, one to three units; Art 493, one unit; Art 496, six to ten units; art history (two courses selected from the group Art 301 through 328),

one and one-half units; electives (Art electives, art history, and/or academic courses approved by the adviser), two to six units. A thesis is required.

Master of Arts with Art Education Major. Students must complete all the following courses for a minimum of eight units: Art 493, one unit; art history (one course selected from the group Art 301 through 328), three-fourths unit; art electives, two and one-fourth units; Educational Psychology 311, one-half unit; Educational Psychology 312, one-half unit; Secondary and Continuing Education 456, one unit; two of the following: History and Philosophy of Education 301, 302, 303, 304, one unit; electives, one unit. No thesis is required. See pages 36 and 37.

Master of Arts with Art History Major. Students must complete all the following courses for a minimum of eight units: Art 493, one unit; art history and architectural history (Art 301-328, 450-455, 492; Architecture 310-317), three units minimum; Art 499 (thesis), one-half to one unit; electives (art history, architectural history, or related fields approved by the adviser), one to three units. A course on the 400 level is required in each of four of the following areas: ancient, medieval, Renaissance, baroque, modern, and oriental. A qualifying examination, normally taken toward the end of the program, tests the student's general knowledge of the whole field of art history. Proficiency in German or French must also be demonstrated. A thesis is required.

Doctor of Education in Art Education. The program leading to the Doctor of Education with a major in art education is designed to provide advanced professional preparation for art educators and to develop educational leaders with a high level of art, and educational competence. The program is offered jointly by the Department of Art and the College of Education.

Admission. A candidate for admission must hold a master's degree in fine arts, or art education, or the equivalent from an accredited institution. He must also have a minimum of two years' acceptable teaching experience. Admission is determined by examinations administered by the Department of Art and the College of Education, personal interviews, record of previous education and experience, and recommendations from persons who have known the candidate. Examinations administered by the Department of Art include art education, art history, and art processes. Portfolios of art work may also be required.

Applicants for admission should present credentials well in advance of their first registration. Planning a program of study requires that examinations and other steps preliminary to admission be completed prior to the registration period. Admission is not complete until the candidate is accepted by two joint advisers, one from the Department of Art and one from the College of Education.

Residence. Minimum residence requirement is one year of uninterrupted work during which a minimum of six units of work is successfully completed. The remaining course work may be completed during summer sessions or during the regular school year.

Program. A minimum of sixteen units of course work beyond the requirements for the master's degree is required, including six units of credit in art and art education and six units of credit in education. The following courses are required: Elementary Education 455, one unit; History and Philosophy of Education 405 and 410, two units; Educational Psychology 390 and 415, two units; Art 493, one unit; a course in research in art education, one unit; electives in art and art education, three units; electives in education, two units; electives, four units.

A thesis is required, but no academic credit is granted for the thesis. General regulations of the Graduate College covering the filing of the thesis title and the preparation, submission, and publication of the thesis must be met.

Doctor of Philosophy in Art History. This program is designed to prepare students for significant, original research and for creative scholarship and teaching on the college level. The history of architecture is an integral part of the curriculum.

Applicants must have a master's degree in the history of art or the equivalent. They must also achieve a high score on the qualifying examination required for the master's degree and be recommended by the graduate committee in the history of art and the history of architecture. In accordance with the requirements of the Graduate College and subject to such special

additional examinations as the graduate committee in history of art and architecture may prescribe, applicants may petition to apply toward the doctor's degree credit for graduate work received at institutions other than the University of Illinois.

All requirements of the Graduate College must be fulfilled in addition to the special stipulations of the program in history of art.

The student specializes and writes his dissertation in an area approved by his adviser and the graduate committee in the history of art and history of architecture.

In addition to the field of specialization, the student selects either one or two approved minors. The single minor, or one of the two if two are chosen, must be in a subject other than the history of art or the history of architecture. Among such approved subjects are anthropology, classics, history, linguistics, literature (English or other), musicology, philosophy, psychology, sociology, speech, and theatre. The first of two minors may be in an area of the history of art.

In addition to credit for the dissertation, a minimum of four units of graduate study (including work for the master's degree) is required in the field of specialization. At least four units of study are required for a single minor. A minimum of three units is required for the first of two minors, two for the second.

A preliminary examination, part written, part oral, is given covering three fields in history of art and the minor in a cognate field. The final examination is oral and consists primarily of the student's defense of the conclusions reached in the dissertation.

An effective reading knowledge of both French and German is required for those who specialize in a phase of western art. Chinese or Japanese will be substituted for one of these languages by those who specialize in the arts of the Far East. The substitution of high proficiency in one language for proficient reading ability in two is not acceptable in history of art. These language requirements must be fully met before the student has earned four units of graduate credit beyond the requirements for the master's degree. In many instances, a working knowledge of a third foreign language will be necessary.

Applicants should fill out a "Graduate Application for Admission or Readmission" and the "Application for Graduate Appointment," if pertinent, and return with transcripts and other supplementary material to W. F. Doolittle, Chairman, Graduate Programs in Art, 140 Fine and Applied Arts Building, University of Illinois, Champaign, Illinois. Students already enrolled at Illinois in the history of art and architecture at the graduate level may apply in writing for admission to the doctoral program. All applicants should include a statement of purpose. No examples of creative work are required.

The Department of Art's brochure, *Graduate Programs in Art*, which deals primarily with master programs in art but contains some information pertinent to Ph.D. applicants, will be sent upon request, as will an application kit.

Although admissions applications are processed throughout the year, applications for grants are only considered in the February 15th screening which precedes expected June or September admission.

If the applicant wishes to correspond directly with the adviser of the program, he should write Professor Alan Laing, 103 Architecture Building, if the major is to be in architectural history.

FACULTY

Professors: J. R. Shipley (Head of Department), E. H. Betts, C. W. Briggs, W. F. Doolittle, P. Fehl, D. E. Frith, F. Gallo, J. W. Kennedy, K. M. Lansing, Ann Perkins, R. Perlman, E. C. Rae, J. Schueler, H. A. Schultz, A. R. Sinsabaugh, M. A. Sprague, R. W. Sterkel, R. A. von Neumann, A. S. Weller, E. C. Wicks, E. J. Zagorski, J. Ziff, N. Ziroli.

Associate Professors: P. Bodnar, F. E. Gunter, A. D. Moore, Minerva Pinnell, L. H. Price, J. A. Savage.

Assistant Professors: J. E. Dowell, Jr., M. Franciscono, G. W. Hardiman, M. D. Hilson, H. C. Jackson, T. G. Kovacs, E. Lancaster, R. Moses, K. Munakata, R. A. Nameth, D. M. Rowan.

COURSES FOR GRADUATES

450. Studies in Modern Art. Investigation of special problems; writings of artists and critics; preparation of critical reports. 1 unit. Prerequisite: Consent of instructor.

451. Studies in American Art. Investigation of special problems; historical development of the study of American art; techniques of conservation and restoration. 1 unit. Prerequisite: Consent of instructor.

452. Seminar in Chinese Art. Investigation of selected phases, concepts, and problems of the art of China; intensive reading and reports. 1 unit. Prerequisite: Art 328 or consent of instructor.

453. Seminar in Japanese Art. Investigation of selected phases, concepts, and problems of the art of Japan; intensive reading and reports. 1 unit. Prerequisite: Art 327 or consent of instructor.

454. Seminar in Ancient Art. Research seminar in problems selected from the art of ancient Mediterranean area. 1 unit. Prerequisite: At least one of the following: Art 304, 305, 306, 307, or equivalent.

455. Seminar in Baroque Art. Research seminar in problems selected from the art of seventeenth-century Europe. 1 unit. Prerequisite: Art 319, 320, or equivalent; or consent of instructor.

467. Graphic Design Laboratory. Individually directed research in problems of visual design with emphasis on the understanding of recent developments in nonverbal communication and the utilization of contemporary graphic processes. 1 to 3 units. Prerequisite: Enrollment in the M.F.A. program in graphic design or consent of departmental graduate committee.

477. Industrial Design Laboratory. Individually directed research in the drafting room or workshop with concentration in industrial design. 1 to 3 units. Prerequisite: Enrollment in the M.F.A. program in industrial design or consent of departmental graduate committee.

491. Special Problems. Individual direction in research and in creative activity; thesis. $\frac{1}{2}$ to 2 units.

492. Individual Readings in History of Art. Directed readings in special fields or aspects of history of art not provided in depth by the current course offerings. $\frac{1}{2}$ to 1 unit. Prerequisite: Consent of instructor.

493. Seminar: Introduction to Methods and Criticism. 1 unit. Prerequisite: Graduate standing in art.

494. Seminar: Studies in the Development of Art History and Criticism. The relation of art history and criticism; changing standards and criteria; intensive reading of selected critical works; the writing of art criticism. 1 unit. Prerequisite: Consent of instructor.

495. Painting Laboratory. Professional and experimental painting with emphasis on the development of maturity of style and personal expression. $\frac{1}{2}$ to 3 units. Prerequisite: Enrollment in the M.F.A. program in painting and printmaking or consent of departmental graduate committee.

496. Sculpture Laboratory. Experience at a professional level in sculptural technique including metals casting, welding, stone carving, wood carving, clay modeling, and ceramic sculpture, with emphasis on the development of creative achievement. 1 to units. Prerequisite: Enrollment in the M.F.A. program in sculpture or consent of departmental graduate committee.

497. Print Workshop. Intaglio, relief, and planographic; printing, including etching, engraving, aquatint, wood, paper and plastic relief printing, and lithography. $\frac{1}{2}$ to 3 units.

499. Thesis Research. Guidance in research and writing theses for advanced degrees. 0 to 4 units. Prerequisite: Graduate standing in history of art.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Greek Painting. Vase paintings, wall paintings, mosaics, and other examples of the graphic art of the Greek world from Mycenaen times through the Hellenistic period. 3/4 unit. Prerequisite: Art 306 or consent of instructor.

302. Art of the Ancient Near East. Focuses on Egypt and Mesopotamia and deals to a lesser degree with the more peripheral or eclectic arts of Persia, Syria-Palestine, and Anatolia. The period extends from the late prehistoric age to the time of Alexander the Great. 3/4 unit. Prerequisite: Art 306 or consent of instructor.

303. Art of the Eastern and Western Roman Empire. Deals with monuments outside Italy both in the eastern and western parts of the Empire. The influence of native traditions and the development of local styles is emphasized. 3/4 unit. Prerequisite: Art 307 or consent of instructor.

304. Greek Sculpture. A survey of the development of Greek sculpture from Mycenean times to the Christian era with analysis of the major works in relief and in the round. 3/4 unit. Prerequisite: Art 306 or consent of instructor.

305. Art of the Augustan Age. A study of the major works of architecture, sculpture, and painting in Italy and the Roman Empire from the time of Augustus. 3/4 unit. Prerequisite: Art 307 or consent of instructor.

306. Near Eastern and Greek Art. Architecture, sculpture, and painting of Egypt, Western Asia, Crete, and of Greece from Mycenean times through the Classical period. 3/4 unit. Prerequisite: One year of history of art or consent of instructor.

307. Hellenistic, Roman, and Byzantine Art. Architecture, sculpture, painting, and mosaics of the Hellenistic world, Italy and the Roman empire, and the Byzantine empire. 3/4 unit. Prerequisite: One year of history of art or consent of instructor.

308. Early Medieval Art. The arts of Byzantium and of Western Europe from the early Christian through the Romanesque period. 3/4 unit. Prerequisite: One year of history of art or consent of instructor.

309. Gothic Art. The arts of Western Europe from the end of the Romanesque period until the Renaissance. 3/4 unit. Prerequisite: One year of history of art or consent of instructor.

310. The History of Printmaking. The development of the various graphic processes in the hands of important printmakers from the fifteenth through the nineteenth centuries. 1/2 or 3/4 unit. Prerequisite: One year of history of art or consent of instructor.

311. German and Austrian Painting of the Late Nineteenth and Early Twentieth Centuries. A survey of modern German and Austrian painters and pictorial movements from the 1890's to the period of Hitler, with special emphasis upon the expressionist period. 3/4 unit. Prerequisite: Art 321 or 322, or one 300-level course in nineteenth-century painting.

312. The Art Nouveau in Europe. A survey of the principal artists and artistic currents in the applied arts during the 1890's in Europe. Emphasis is on individual figures, with an attempt to define the common stylistic and theoretical assumptions of the period. 3/4 unit. Prerequisite: Art 321 or one 300-level course in nineteenth-century art or architecture.

313. Italian Renaissance Art. Architecture, painting, sculpture, and minor arts of Italy during the Renaissance. 3/4 unit. Prerequisite: One year of history of art or consent of instructor.

314. Northern Renaissance Art. Architecture, painting, sculpture, and minor arts of France, Germany, Spain, and England in the sixteenth, seventeenth, and eighteenth centuries. 3/4 unit. Prerequisite: One year of history of art or consent of instructor.

315. Art of the Nineteenth Century. Architecture, painting, sculpture, and minor arts of the nineteenth century in France, Germany, Spain, and England. 3/4 unit. Prerequisite: One year of history of art or consent of instructor.

316. Later Chinese Painting. A study in depth of later phases of Chinese painting, particularly that of the Ming and Ch'ing dynasties; connoisseurship in Chinese painting. 3/4 unit. Prerequisite: Art 328, or a course in Chinese history of the period covered, or consent of instructor.

317. Italian Art of the Sixteenth Century. Painting, sculpture, and minor arts in Italy from 1520 to 1590. 3/4 unit. Prerequisite: One year of history of art or consent of instructor.

318. Latin-American Art. Study of the more important phases and periods of the visual arts of Latin America. 3/4 unit. Prerequisite: One year of history of art or consent of instructor.

319. Italian Art of the Seventeenth and Eighteenth Centuries. An examination of the arts of painting, sculpture, and architecture of the seventeenth and eighteenth centuries in Italy in terms of major figures and dominant stylistic tendencies. 3/4 unit. Prerequisite: One year of history of art or consent of instructor.

320. Northern European Art of the Seventeenth and Eighteenth Centuries. An examination of major developments in painting, sculpture, and architecture in the Low Countries, France, Spain, and England during the seventeenth and eighteenth centuries, in terms of major figures and dominant stylistic developments. 3/4 unit. Prerequisite: One year of history of art or consent of instructor.

321. Twentieth-Century Art, 1900 to 1925. Study of the leading personalities and movements in Western painting, sculpture, and architecture, with emphasis on the first. 3/4 unit. Prerequisite: One year of history of art or consent of instructor.

322. Twentieth-Century Art, 1925 to Date. Study of the leading personalities and movements in Western painting, sculpture, and architecture, with emphasis on the first. 3/4 unit. Prerequisite: One year of history of art or consent of instructor.

323. American Art to 1840. Architecture, painting, sculpture, and minor arts of the Colonies and the United States to 1840. 3/4 unit. Prerequisite: One year of history of art or consent of instructor.

324. American Art, 1840 to 1900. Architecture, painting, sculpture, and minor arts of the United States. 3/4 unit. Prerequisite: One year of history of art or consent of instructor.

325. Recent American Painting and Sculpture. Current developments, with special emphasis on works shown in contemporary exhibitions at the Krannert Art Museum. 1/2 or 3/4 unit. Prerequisite: One year of history of art or consent of instructor.

326. Art of Medieval Japan. A study of Japanese art, primarily painting, from the thirteenth century, with emphasis on the work of individual artists. 3/4 unit. Prerequisite: Art 327, or a course in Japanese history of the period covered, or consent of instructor.

327. Japanese Art. History of Japanese art from earliest times to the twentieth century. 3/4 unit. Prerequisite: One year of history of art.

328. Chinese Art. History of Chinese art from earliest times to the present. 3/4 unit. Prerequisite: One year of history of art.

380. Drawing. Advanced drawing in several media. 1/2 to 1 unit. Prerequisite: Art 126 or equivalent; for graduate students, consent of departmental graduate committee.

381. Painting. Advanced painting in oil and other media. Not open to candidates for the Master of Fine Arts in painting and printmaking. 1/2 to 1 unit; may be repeated for a total of 2 units. Prerequisite: Art 142 or equivalent; for graduate students, consent of departmental graduate committee.

382. Painting Materials and Techniques. Study of the materials and techniques used in the various media: oil, watercolor, tempera, gouache, encaustic, etc. 1/2 unit. Prerequisite: Art 142 or graduate standing in art.

383. Print Media. Advanced work in various printmaking techniques. Not open to candidates for the Master of Fine Arts in painting. 1/2 to 1 unit. Prerequisite: Art 284 or equivalent; for graduate students, consent of departmental graduate committee.

385. Lithography. Laboratory course in lithography. Course of study includes a complete development of the process, exploiting its potential as a fine art medium. ½ to 1 unit. Prerequisite: Art 286: for graduate students, consent of departmental graduate committee.

387. Photography. Emphasis on development of mature creative attitudes through use of personal images and interpretations. Work in black and white, and color. ½ or 1 unit; may be repeated for a total of 2 units. Prerequisite: Art 216 or equivalent; consent of instructor.

388. Cinematography. Theory and practice of motion pictures as an art form. Emphasis is on individual creative production. ½ to 1 unit; may be repeated to a maximum of 2 units. Prerequisite: Art 215; consent of instructor.

391. Advanced Sculpture Techniques. Advanced work in various sculptural media. ½ to 1 unit. Prerequisite: Art 252 or equivalent.

392. Silversmithing, I. Advanced course in design and execution of hollowware, dealing primarily with raising and spinning methods and with the decorative process of chasing, repoussé, niello, filigree, and inlay. ½ to 1 unit. Prerequisite: Consent of instructor.

393. Silversmithing, II. Advanced course in design and execution of flatware and hollowware, dealing primarily with forging and scanning methods, engraving, and toolmaking. ½ to 1 unit. Prerequisite: Consent of instructor.

394. Ceramic Design. Ceramic design with emphasis on the development of professional style and personal expression. ½ to 2 units. Prerequisite: Art 295 or consent of instructor.

ASIAN STUDIES

(Including Burmese, Chinese, Indonesian, Japanese, Korean, and Persian)

A graduate minor in Asian studies is administered by the Center for Asian Studies in cooperation with various departments. It is possible for a graduate student electing this minor to concentrate on East Asia, Southeast Asia, South Asia, or the Near and Middle East, or a combination of two or more of these areas.

A candidate for a master's degree who elects Asian studies as a minor must earn at least two units of graduate credit in at least two departments from approved courses.

A doctoral candidate who elects Asian studies as a minor must earn at least four units of graduate credit in at least two departments from approved courses.

The courses chosen for the graduate minor must be in departments outside the candidate's major. The list of the courses which may be chosen to satisfy the minor in Asian studies is available at the Center for Asian Studies, 1208 West California Avenue, Urbana.

Also, the doctoral candidate must, prior to the completion of his course requirements for the degree, complete satisfactorily one of the following: Arabic 304, Burmese 304, Chinese 304, Hindi 304, Indonesian 304, Japanese 304, or equivalent.

Candidates should contact the Director of the Center for Asian Studies regarding additional courses which would be acceptable.

Students who do not elect an Asian studies minor but who seek knowledge of Asian affairs, cultures, and languages are invited to consult, either directly or through their advisers, with the Director of the Center or with faculty associated with the Center in order to develop programs suited to their individual needs.

The adviser for the graduate minor is Professor Robert B. Crawford, Director of the Center for Asian Studies, 1208 West California Avenue, Urbana.

FACULTY

Professors: E. Bruner, C. E. Dawn, F. Fliegel, N. Jacobs, B. Karsh, F. K. Lehman, B. Nettl, D. Plath, A. Ringer, P. Schran, K. Taira, G. L. Tikku.

Associate Professors: R. Crawford (Diector of Center), L. Eastman, H. Gould, B. Kachru, Yamuna Kachru, C. Kim, B. Kling, E. Wolff, G. Yu.

Assistant Professors: D. Abdo, R. Chang, S. Cohen, R. Cummings, S. Douglas, E. Eide, S. Makino, K. Munakata, A. Netzer, T. Unno, H. Wechsler, P. Wiebe, J. Yegerlehner.

Burmese

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. Intermediate Burmese, I. Introduction to a wider variety of styles and contexts of discourse and usage; written Burmese and an orderly view of Burmese grammar. 1 unit. Prerequisite: Burmese 202 or equivalent. Lehman.

304. Intermediate Burmese, II. Concentration upon ability to engage in active and reasonably fluent discourse in Burmese, on the grammar of sentence formation and ability to read ordinary Burmese texts. 1 unit. Prerequisite: Burmese 303 or equivalent. Lehman.

Chinese

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

305. Advanced Chinese, I. Reading and translation of graded selections from modern Chinese literary and journalistic writing. ½ unit. Prerequisite: Chinese 304 or equivalent. Chang.

306. Advanced Chinese, II. Reading in modern Chinese literary and journalistic writings; introduction to classical Chinese to prepare students of modern Chinese to understand classical forms and quotations occurring in vernacular text and to use dictionaries and reference works. ½ unit. Prerequisite: Chinese 305 or equivalent. Chang.

307. Introduction to Literary Chinese. An introduction to literary language, style, and structural patterns as reflected in the Confucian Classics and other literary, philosophical and historical texts. 1 unit. Prerequisite: Chinese 306. Eide.

308. Readings in Literary Chinese. Readings in texts selected from the Confucian Classics and other literary, philosophical, and historical texts. Attention is given to linguistic and intellectual patterns and problems of translation. ½ or 1 unit. Eide.

309. Social Science Readings in Chinese. Reading and translation of selected Chinese texts in the social sciences with emphasis on specialized terminology and prose style. ½ or 1 unit. Prerequisite: Chinese 306. MacDonald.

310. Modern Chinese Literature. Reading and analysis of selected works of Chinese literature since the May 4th movement with special attention to the relationship between literature and ideology in twentieth-century China. 1 unit. Prerequisite: Chinese 306. MacDonald.

320. Readings in Chinese and Japanese Buddhist Texts. Same as Japanese 320. Readings in selected Buddhist philosophical, religious, and historical literature in Chinese and Japanese. ½ or 1 unit. Prerequisite: Chinese 306 or Japanese 306, or consent of instructor. Unno.

330. Introduction to Far Eastern Linguistics. Same as Japanese, Korean, and Linguistics 330. Introduction to genetic relation of the Far Eastern languages with other languages. Concentration on synchronic analysis of phonology and syntax. 1 unit. Prerequisite: Linguistics 300; consent of instructor.

350. Research Methods and Bibliography in Chinese Studies. Introduction to the problems of translation and to the variety, nature, structure, and usage of Chinese reference works. Exercises are assigned involving application of research methods peculiar to Chinese studies and the use of the appropriate reference aids. 1 unit. Prerequisite: Chinese 307 or consent of instructor. Eide.

Indonesian

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. Intermediate Indonesian, I. First term of second year of work in the Indonesian language, with drill for more advanced conversational fluency; introduction to a greater variety of styles and levels of discourse and usage, increasing study of the written language, and more formal grammar. 1 unit. Prerequisite: Indonesian 202 or equivalent. YEGERLEHNER.

304. Intermediate Indonesian, II. Concentration upon ability to engage in reasonably fluent discourse in Indonesian, on comprehensive knowledge of grammar, and on ability to read ordinary written Indonesian. 1 unit. Prerequisite: Indonesian 303 or equivalent. YEGERLEHNER.

Japanese

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. Intermediate Japanese, I. First term of second year of work in the Japanese language, with drill for increased conversational fluency; introduction to a greater variety of styles and levels of discourse and usage, increasing study of the written language, and more formal grammar. 1 unit. Prerequisite: Japanese 202 or equivalent. MAKINO.

304. Intermediate Japanese, II. Concentration upon ability to engage in reasonably fluent discourse in Japanese, on comprehensive view of formal grammar, and on ability to read simple written Japanese. 1 unit. Prerequisite: Japanese 303 or equivalent. MAKINO.

305. Advanced Japanese, I. Course for advanced knowledge of Japanese with emphasis on reading. 1 unit. Prerequisite: Japanese 304 or equivalent. MAKINO.

306. Advanced Japanese, II. Course for advanced knowledge of Japanese with emphasis on reading. 1 unit. Prerequisite: Japanese 305 or equivalent. MAKINO.

309. Social Science Readings in Japanese. Readings in Japanese social science materials, including articles from newspapers, periodicals, and learned journals. 1 unit. Prerequisite: Japanese 306.

310. Modern Japanese Literature. Readings and analysis of selected Japanese texts, primarily fiction. 1 unit. Prerequisite: Japanese 306.

320. Readings in Chinese and Japanese Buddhist Texts. Same as Chinese 320. Readings in selected Buddhist philosophical, religious, and historical literature in Chinese and Japanese. 1 unit. Prerequisite: Chinese 306 or Japanese 306, or consent of instructor. UNNO.

330. Introduction to Far Eastern Linguistics. Same as Chinese, Korean and Linguistics 330. Introduction to genetic relation of the Far Eastern languages with other languages. Concentration on synchronic analysis of phonology and syntax. 1 unit. Prerequisite: Linguistics 300; consent of instructor.

Korean

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. Intermediate Korean I. Second year of Korean. More drill for advanced conversational fluency. Introduction to a greater variety of styles and levels of discourse and usage. 1 unit. Prerequisite: Korean 202 or equivalent. KIM.

304. Intermediate Korean II. Continuation of Korean 303. Concentration on ability to read ordinary text. Increasing study of grammar and more Hanc'a. 1 unit. Prerequisite: Korean 303 or equivalent. KIM.

330. Introduction to Far Eastern Linguistics. Same as Chinese, Japanese, and Linguistics 330. Introduction to genetic relation of the Far Eastern languages with other languages. Concentration of synchronic analysis of phonology and syntax. 1 unit. Prerequisite: Linguistics 300; consent of instructor.

Persian

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. Intermediate Persian, I. A general review of the essentials of grammar, selected reading of materials emphasizing Iranian life and culture, compositions, and practice in speech. 1 unit. Prerequisite: Persian 202 or consent of instructor. NETZER.

304. Intermediate Persian, II. A general review of the essentials of grammar, selected reading of materials emphasizing Iranian life and culture, compositions, and practice in speech. 1 unit. Prerequisite: Persian 303 or consent of instructor. NETZER.

305. Advanced Persian, I. Designed to improve competence in speaking, writing, and reading Persian. Includes reading in modern and classical Persian prose and poetry. ½ unit. Prerequisite: Persian 304 or consent of instructor. NETZER.

306. Advanced Persian, II. Continuation of Persian 305. Designed to improve competence in speaking, writing, and reading Persian. Includes reading in modern and classical Persian prose and poetry. ½ unit. Prerequisite: Persian 305 or consent of instructor. NETZER.

309. Contemporary Persian Literature and Western Influence (in translation). Same as Comparative Literature 309. Readings in modern Persian literature in translation, and the study of selected European novels and works on literary theory with specific attention to Western influence on Persian literature. ½ to 1 unit. Prerequisite: Consent of instructor. TIKKU.

ASTRONOMY

The Department of Astronomy offers graduate work leading to the Master of Science and Doctor of Philosophy in Astronomy (including radio astronomy). Admission requires a minimum grade-point average of 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis. In addition, the normal entrance requirements are as follows: (1) a bachelor's degree in astronomy, physics, electrical engineering, or mathematics, and (2) a one-year course in descriptive astronomy.

The eight units for the Master of Science may be obtained in three ways, listed as (1), (2), and (3) below. Alternative (3) is intended for students wishing to specialize in radio astronomy.

(1) All eight units may be taken in astronomy; at least three units must be at the 400 level.

(2) Two units may be selected from approved courses in mathematics; two units may be taken in approved courses in physics; the remaining units must be taken in astronomy. At least three units must be at the 400 level, and at least two of these three units must be taken in astronomy.

(3) Five units may be earned by taking Physics 341, 342, Electrical Engineering 420, 421, and Astronomy 357. The remaining three units must be taken in astronomy; only one of these units need be at the 400 level.

Details regarding the Doctor of Philosophy may be obtained by writing to the Head of the Department, University of Illinois Observatory.

For information regarding applied mathematics, see page 292.

FACULTY

Professors: G. C. MCVITTIE, G. W. SWENSON, JR., S. P. WYATT, K. M. YOSS.

Associate Professors: J. H. Cahn, J. R. Dickel, J. B. Kaler, E. C. Olson.
Assistant Professor: E. S. Avner.

COURSES FOR GRADUATES

401. Stellar Atmospheres. Physical characteristics of stellar atmospheres as derived from spectroscopic observations; radiation transfer, theory and observations of the continuous spectrum, limb darkening; formation of absorption lines, line profiles, curves of growth, relative chemical abundances; emission features; forbidden radiation. 1 unit. Prerequisite: Consent of instructor. Kaler.

403. Gaseous Nebulae and the Interstellar Medium. Distribution, structure, and spectra of nebulae; physical processes in planetary and diffuse nebulae; recombination, fluorescence, and forbidden line radiation; determination of physical parameters; nature of the interstellar medium; interstellar gas and grains; observation of insterstellar medium. 1 unit. Prerequisite: Astronomy 301. Kaler.

404. Theory of Stellar Structure. Masses, luminosities, radii, and surface temperature of stars; basic equations and stability conditions; nuclear reactions; integration of basic equations; results—initial stages, later stages, white dwarfs. 1 unit. Prerequisite: Consent of instructor. Olson.

415. Experimental Methods in Radio Astronomy. Design and construction of instruments for radio astronomy; techniques of observation of celestial radio sources; interpretation of data. 1 unit; may be taken a second time for credit. Prerequisite: Consent of instructor. Swenson.

424. Relativity and Cosmology. Same as Mathematics 460 and Physics 424. Elements of tensor calculus and Riemannian geometry; special relativity; Lorentz transformations, equivalence of mass and energy; general relativity and the gravitational field of the sun; galaxies and cosmology. 1 unit. Prerequisite: Consent of instructor. McVittie.

433. Solar System Astrophysics. Planetary orbits and perturbations; physical perturbations; physical parameters of the planets; planetary interiors, atmospheres, magnetospheres, and surface layers; the satellites; asteroids and comets; meteors, meteorites, and tektites; interplanetary grains and gas; problems of origin and evolution. 1 unit. Prerequisite: Consent of instructor. Dickel, Wyatt.

486. Constitution of the Ionosphere: An Introduction to Aeronomy. Same as Electrical Engineering 486. Properties of the neutral and ionized atmosphere above 60 km. height, and the photochemical processes causing them; diffusion of ionospheric constituents; solar and meteoric perturbations of the ionosphere. 1 unit. Prerequisite: Graduate standing in electrical engineering, physics, or astronomy; Mathematics 341 or equivalent. Bowhill.

491. Seminar in Special Topics. 1 to 4 units. Prerequisite: Consent of instructor. Staff.

499. Thesis Research. 0 to 3 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Introductory Astrophysics. Stars, observational data and their determination; atoms and radiation; stellar atmospheres; equilibrium of stellar interiors; special types of stars, interstellar matter. 1 unit. Prerequisite: Physics 108. Olson.

302. Astrophysics of the Sun. Observations of the sun at all wavelengths and application of the results to the study of the photosphere, chromosphere, and corona; structure of the atmosphere of the quiet sun; solar activity. 1 unit. Prerequisite: Astronomy 301. Dickel.

306. Foundations of Mechanics and Gravitational Theory. Same as Aeronautical and Astronautical Engineering 306. Introduction to the dynamics of particles and rigid bodies with special emphasis on elementary planetary motion, motion of a rocket, motion of

long-range projectile relative to Earth, precession of Earth's axis, etc. 1 unit. Prerequisite: Mathematics 142 or 143. AVNER.

307. Celestial Mechanics. Two-body problem; Kepler's equation; planet's orbit in space; distance in solar system; gravitational potential; perturbations in planetary motion; dynamical theory of stars of high velocity; spiral arm of galaxy. 1 unit. Prerequisite: Astronomy 306 or Physics 322. AVNER.

314. Observational Astronomy. Same as Civil Engineering 305. Astronomical coordinate systems and transformations; theory of, and practice in, approximate and precise determinations of latitude, longitude, and time; introduction to theory of errors; theory and practice of astronomical photography. 1 unit. Prerequisite: Astronomy 102 or 210, or Civil Engineering 201; Mathematics 142 or 143. WYATT.

315. Observational Techniques and Reductions. Methods of observation and reductions in photographic and photoelectric photometry, spectrophotometry, and stellar radial velocity determinations. 1 unit. Prerequisite: Astronomy 314. YOSS.

317. Elements of Magnetohydrodynamics. Same as Aeronautical and Astronautical Engineering 317. Equations of magnetohydrodynamics, single-fluid and multiple-fluid models, magnetic interaction parameters, magnetosonic waves, hydromagnetic shock waves, aligned-field and crossed-field flows, theory of characteristics, MHD acceleration, generation, and propulsion. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 213 or consent of instructor. BOND.

321. Stellar Systems, I. Galactic structure: the observational data; stars in the solar neighborhood; the solar motion; stellar statistics and distribution; stellar populations; interstellar matter and spiral structure; the whole galaxy. 1 unit. Prerequisite: Astronomy 102 or 210; Physics 108. YOSS.

322. Stellar Systems, II. Continuation of Astronomy 321. Galactic dynamics: stellar motions; galactic rotation; dynamics and mass distribution; stellar encounters; dynamics of interstellar matter. Galaxies: distances, structural features; groups and clusters; radio galaxies and quasars; spatial distribution and motions. 1 unit. Prerequisite: Astronomy 321. WYATT.

357. Radio Astronomy. Same as Electrical Engineering 357. Instrumental theory and observational technique; radar and meteors; the moon and planets; solar radio waves; galactic and extragalactic radio astronomy. 1 unit. Prerequisite: Physics 108. SWENSON.

366. Aeronomy: Physics of the Upper Atmosphere and Space. Same as Electrical Engineering and Physics 366. Structure and composition of the Earth's upper atmosphere, solar radiation and its interaction with the upper atmosphere; the ionospheric layers; planetary atmospheres; airglow and aurora; interplanetary plasma; the magnetic field of the Earth and its interaction with the solar plasma; experimental techniques. 1 unit. Prerequisite: Physics 321, 342, and 381; or consent of instructor. RAETHER.

BIOCHEMISTRY

Biochemistry is a multidisciplinary field resulting from the interactions of chemistry and physics with biology. Biochemistry staff offer training in biochemistry, and also in molecular biology and biophysical chemistry (see below and also pages 116 and 122). Programs leading to graduate degrees in biochemistry are offered in the Biochemistry Division of the Department of Chemistry and Chemical Engineering. Entering graduate students in biochemistry must therefore meet the graduate entrance requirements of that department (see page 116).

Interested students should contact the Biochemistry Division.

BIOLOGY

See descriptions and course listings under Life Sciences, page 255.

BIOPHYSICS AND BIOPHYSICAL CHEMISTRY (MOLECULAR BIOLOGY)

Biophysics is a rapidly growing field that cuts across many disciplines. An area overlapping with this and developing through interaction of chemistry and biology is that of biophysical chemistry.

Since graduate study in biophysics and biophysical chemistry involves several areas of biological and physical sciences, the Graduate College has adopted a flexible system enabling students to enter special interdisciplinary programs in these areas, thus affording them a wide range of opportunity for study and research in borderlands between the biological and physical sciences.

For the program leading to the Doctor of Philosophy in Biophysics, see descriptions and course listings under Life Sciences, pages 266 and 270.

Students majoring in chemistry or microbiology may elect to specialize in biological problems at the molecular level (see pages 116 and 263). Students in other areas of the biological and physical sciences who wish to arrange programs of study emphasizing biophysics should direct their inquiries to the head of the major department.

BOTANY

See descriptions and course listings under Life Sciences, page 257.

BUSINESS

The Doctor of Philosophy in Business is awarded to those who complete the subject matter requirements listed below and the general requirements outlined in the first section of this catalog. The subject matter requirements represent primarily a carefully selected group of subjects offered in the several fields of the College of Commerce and Business Administration.

Candidates for the degree should have a training such as that represented by graduation from an accredited college of commerce or school of business. Students who have not graduated from such college or school or from an institution offering an equivalent program must present a minimum of thirty hours in commerce subjects, including at least one course in each of the following: accountancy, economics, management, and marketing. Those candidates who hold a master's degree in economics or business can usually complete the requirements in two years by synchronization of courses previously taken with those offered in this program.

In lieu of the usual major and minor requirements for the doctorate, candidates for the Doctor of Philosophy in Business must prepare themselves for examination in five fields. Two of these, management and economic theory, are required, but the other three are elective. One of the elective fields may be outside the College of Commerce and Business Administration and must include at least two units. Within these requirements, it is expected that each student will select, in consultation with his adviser, an individual program of study to meet his specific needs and objectives. For numbers and titles of courses available, see the listings in this catalog under accountancy, economics, finance, and business administration.

Because the major fields for this degree cross departmental lines, administration of the work is supervised by a committee. A doctor's dissertation constitutes the work of the third graduate year. Correspondence relating to the degree should be addressed to the Chairman of the Committee on the Doctor of Philosophy Degree in Business, 350 Commerce and Business Administration Building (West).

COURSES FOR GRADUATES

499. Thesis Research. 0 to 4 units.

BUSINESS ADMINISTRATION

(Including Industrial Administration and Marketing)

The Department of Business Administration offers programs leading to graduate degrees in Business Administration, Management, and Marketing.

The Department offers professional programs in business administration leading to the degrees of Master of Business Administration, Doctor of Business Administration, and Master of Commerce.

Master of Business Administration. The Master of Business Administration program is designed primarily for students whose undergraduate preparation is in liberal arts and sciences, engineering, or other nonbusiness areas. Students whose undergraduate preparation is in business may apply for admission, and the make-up of programs of those admitted is frequently adjusted to account for the special preparation of the degree candidate. The M.B.A. program requires a minimum of sixteen units or sixty-four semester hours of course work. No thesis is required. Candidates are admitted in September and February.

Doctor of Business Administration. Applications for the Doctor of Business Administration program should have completed their master's program in the upper one-half of their master's class. A minimum of eight units of professional courses beyond the master's degree is required. Candidates who have earned a master's degree from one-year programs are required to complete a minimum of sixteen units of course work. Candidates are admitted in September, February, and June.

Master of Commerce. The Master of Commerce program is designed specifically for students whose undergraduate preparation is in business. Candidates for the Master of Commerce degree are required to take an evaluation examination upon entering the program. This examination covers the equivalent of the first-year M.B.A. program. An outstanding performance on this examination permits granting of the Master of Commerce degree after completion of eight units of course work. Normally, a candidate who is well prepared in the several areas of business administration is required to complete twelve to fourteen units of work.

Acceptance in any of the above professional programs requires a grade-point average of at least 3.5 on a 5.0 scale in the last sixty hours of undergraduate work and an acceptable score on the Admission Test for Graduate Study in Business.

INDUSTRIAL ADMINISTRATION (MANAGEMENT)

The Department offers graduate work either as a major or a minor leading to the Master of Science in Management, and as a minor for the Doctor of Philosophy.

Admission requires a grade-point average of 4.0 for the last sixty hours of undergraduate study. Candidates with a grade-point average from 3.75 to 4.0 may be considered on an individual basis. Such students may be required to take an appropriate examination such as the Admission Test for Graduate Study in Business.

To do major work in the field of management, a student must have completed at least twenty hours of undergraduate work in business administration and related subjects. To do minor work in this field, at least twelve hours of work in business administration and related subjects are required.

MARKETING

Graduate work may be taken in the field of marketing for a major or a minor for the Master of Science and for the Doctor of Philosophy. To do major work in this field, a student must have a grade-point average of at least 3.5 and adequate undergraduate training in business and marketing, quantitative analysis, and the social sciences. Applicants are also required to take the Admission Test for Graduate Study in Business. The program of each student, including the selection of an appropriate minor, must be approved by the graduate adviser or head of the department.

ALL PROGRAMS

Additional information concerning the requirements of the various degree programs may be obtained from the Department of Business Administration, 350 Commerce and Business Administration Building (West).

FACULTY

Professors: N. M. Bedford, R. N. Corley, P. M. Dauten, Jr., R. V. Evans, R. Ferber, R. M. Hill, F. M. Jones, J. W. McGuire, P. C. Roberts, H. M. Schoenfeld, J. L. Simon, W. E. Thomas.

Associate Professors: R. L. Black, H. Hinimoto, B. F. Kirkpatrick, R. D. Millican, L. J. Rago, D. M. Roberts, J. N. Sheth, S. Sudman.

Assistant Professors: R. Abrams, R. J. Arnould, H. L. Beekley, M. H. Berhold, J. B. Cohen, J. R. Cooper, W. F. Egloff, D. M. Gardner, R. K. Ingersoll, K. M. Rowland, W. D. Seitz.

Business Administration

COURSES FOR GRADUATES

401. Scientific Management, I. (Formerly Industrial Administration 401.) Same as Industrial Engineering 401. A study of modern management principles on the basis of methods, concentrating on such operations research techniques as nonlinear and dynamic programming and queueing theory. 1 unit. Prerequisite: Industrial Engineering 386 and Mathematics 361, or consent of instructor.

402. Scientific Management, II. (Formerly Industrial Administration 402.) Same as Industrial Engineering 402. A systems approach to industrial problems involving inventory control, scheduling and line balancing, maintenance and investment theory; application of formally accumulated knowledge of operations research techniques. Problems from industry are assigned to small teams of students. 1 unit. Prerequisite: Business Administration or Industrial Engineering 401; background in computer technology or consent of instructor.

405. Marketing Theory and Systems. (Formerly Marketing 401.) A detailed study of macro- and micro-marketing systems and the various approaches to marketing theory; attention is given to general systems theory, the nature of marketing systems, system adaptation to the environment, concepts of theory, and major approaches to macro and micro theory in marketing. 1 unit.

406. Development of Marketing Thought. (Formerly Marketing 402.) The emphasis in this course is placed on an analysis of marketing thought from the late 1800's to the present. Although attention is directed primarily to general marketing and marketing management. consideration is also given to major contributions in selected areas of marketing. The literature and scholars selected are evaluated both as reflections of their times and as contributions or contributors to contemporary thought. 1 unit. Prerequisite: Business Administration 405.

407. Comparative Marketing Systems. (Formerly Marketing 407.) Examination of comparative marketing systems. Topics include specification and identification of structural elements of systems, analysis of static and dynamic properties, methods of analyzing systems such as input-output and flow analysis, the role of marketing in comparative economic systems, and the role of marketing in developing economies. 1 unit. Prerequisite: Business Administration 405.

410. Organizational Sciences, I. (Formerly Industrial Administration 410.) Same as Political Science 460, Psychology 453, and Sociology 456. An introduction to the principal theories and important empirical research in various disciplines that study organizations. In addition to examination of the subject matter content of various disciplines, students critically examine the capacities and limitations of the various fields

to make contributions to the study of organizations. 1 unit. Prerequisite: Enrollment as a major in organizational sciences in a cooperating program or approval of instructor.

411. Organizational Sciences, II. (Formerly Industrial Administration 411.) Same as Political Science 461, Psychology 454, and Sociology 457. An introduction to the principal theories and important empirical research in various disciplines that study organizations. In addition to examination of the subject matter content of various disciplines, students critically examine the capacities and limitations of the various fields to make contributions to the study of organizations. 1 unit. Prerequisite: Business Administration 410.

415. Foundations of Consumer Behavior. (Formerly Marketing 415.) A study of basic factors influencing consumer behavior. Attention is focused on psychological, sociological, and economic variables, including motivation, learning, attitude, personality, small groups, social class, demographic factors, and culture, to analyze their effects on purchasing behavior. 1 unit.

416. Consumer Information Processing. (Formerly Marketing 416.) Analysis of information flows between buyer and seller; informational properties of demand stimulation strategies are considered from the viewpoints of the firm, consumer, and society; consumer decision making is examined drawing upon the psychology and sociology of buyer motivation and social influence. 1 unit. Prerequisite: Business Administration 415.

421. Marketing Strategy: Theoretical Foundations. (Formerly Marketing 421.) A formal analysis of strategy drawing on concepts from the theory of games, decision theory, value theory, and information theory. Topics covered are elements of game models, classes of decision problems, games against nature, modern utility theory, information theory, group decision making, statistical decision theory, and linear and nonlinear optimization. 1 unit.

422. Marketing Strategy: Decision Models. (Formerly Marketing 422.) The role of models in the design, implementation, and adjustment of seller strategy; application of simulation, programming, and other methods to the specification and solution of product price, promotion, and other marketing problems. Topics covered include the nature of models and model building, forecasting models, optimization models, and other decision models. 1 unit. Prerequisite: Business Administration 421.

444. Problems in Business Policy. (Formerly Industrial Administration 416.) Advanced problems in policy evaluation, determination, execution, administration, and control. Policy objectives in integration of product, marketing, manufacturing, finance, and organization. 1 unit. Prerequisite: Consent of instructor.

448. Problems of Personnel Management. (Formerly Industrial Administration 448.) Same as Labor and Industrial Relations 448. An examination of the organization and administration of the personnel function in management. This course deals with the relations of personnel administration to operating departments, and the scope of business and industrial personnel services. Analytical appraisal of policies and practices in selected areas of personnel administration, such as selection and training, is carried out through case studies and direct industrial contracts. Specific consideration is given to problems up to and including placing the person on a job. 1 unit. Prerequisite: Business Administration 248 or equivalent; consent of instructor.

449. Problems of Personnel Management. (Formerly Industrial Administration 449.) Same as Labor and Industrial Relations 449. A seminar and laboratory course dealing with the problems and practices encountered by personnel managers subsequent to the employment process. Students do field work in businesses and industries in the area on such topics as incentives, rating, employee services, and community relations. 1 unit. Prerequisite: Business Administration 448 or equivalent.

471. Survey Methods in Marketing Research. (Formerly Marketing 474.) Same as Sociology 474. An analysis of survey methods in marketing with emphasis on sample design, data collection, and data processing; an advanced course in the methods re-

quired to design, implement, and evaluate a research project. 1 unit. Prerequisite: Economics 171 or equivalent.

472. Multivariate Methods in Marketing. (Formerly Marketing 472.) The use of multivariate statistical methods in marketing research. Topics covered include multiple regression and correlation, analysis of variance and covariance, canonical correlation, discriminant analysis, factor analysis, and simultaneous methods such as two-stage least squares and limited information one-maximum likelihood. 1 unit. Prerequisite: Economics 470.

473. Experimental Design. (Formerly Marketing 473.) Training in the design, execution, and interpretation of field and laboratory experimental research. Emphasis is placed on the evaluation of alternative designs, execution of problems, and interpretation of data; a review of illustrative research studies is made, an actual study is designed, and data is collected and interpreted. 1 unit.

474. Operations Research. A study of quantitative techniques useful in economic analysis and decision making. Mathematical programming, dynamic programming, queueing theory, renewal theory, and simulation methods are applied to economic control systems with special emphasis on the problems of the firm. Offered in 1971-1972 and in alternate years. 1 unit. Prerequisite: Mathematics 363 and Business Administration 374 or equivalent. SHUPP.

485. The Sampling of Human Population and Social Organizations. (Formerly Marketing 485.) Same as Sociology 485 and Psychology 485. This course covers procedures for selecting samples from and estimating population parameters for human populations and social organizations. The types of sample designs treated include simple random samples, stratified, and cluster samples together with random number and systematic selection techniques. Emphasis is given to the study of various kinds of advanced sample designs for both area and institutional settings together with the problems involved in the application of analytical statistics to complicated sampling procedures. Each student is required to participate in a field project which involves the actual selection of a cluster sample from the local area. 1 unit. Prerequisite: Sociology 387 or Economics 371, or consent of instructor.

490. Seminar in Marketing. (Formerly Marketing 490.) A special topics course in the general area of marketing. Topics are selected by the instructor at the beginning of each semester. 1 unit.

491. Seminar in Special Topics. (Formerly Industrial Administration 491.) For lectures in topics of current interest not covered by regular course offerings. Subjects will be announced in the Time Table. $\frac{1}{4}$ to 1 unit. Prerequisite: Consent of instructor or department head.

493. Research in Special Fields. (Formerly Marketing 493.) $\frac{1}{4}$ to 2 units.

499. Thesis Research. (Formerly Industrial Administration and Marketing 499.) Thesis or independent study. 0 to 4 units.

500. Business Economics. Analysis of supply and demand functions in an uncertain environment; practical applications of economics to the management of business enterprise; the firm's place in the economic system; the place of the enterprise in national accounts. Case materials are used. $\frac{3}{4}$ unit. Prerequisite: Enrollment in a graduate program.

501. Managerial Economics. Monetary and national income analyses essential to understanding governmental policies directed to macro-economic goals; the impact of such policies on the individual business firm and on decision-making by business management; the responsibilities of the individual business firms in contributing to the attainment of social goals of a macro-economic nature; the role of the business leader in formulating public policy in the macro-economic area. $\frac{3}{4}$ unit. Prerequisite: Business Administration 500 or equivalent.

510. Administrative Behavior. This course focuses on the problems faced by an administrator in an interpersonal setting. Primary emphasis is on the analysis of individual and group behavior in a union and nonunion work setting and the determination of actions which the administrator can take to promote desired work performance. Extensive use is made of theory and research related to individual and group behavior to aid in the diagnosis of problems covered. Students take part in either laboratory or field studies. Credit is not given for both Business Administration 510 and 408. ¾ unit. Prerequisite: Enrollment in a graduate program.

511. Business Organization. An analysis of business organization. Major emphasis is on the processes of allocation, coordination, and communication, making decisions about organizations under conditions of certainty and uncertainty for optimal performance, and measures of organizational performance. Critical examination of factors involved in choosing either a centralized or a decentralized style of organization. ¾ unit. Prerequisite: Business Administration 510.

512. Business Organization and Its Environment. An analysis of business organizations adapting to shifts in internal and external elements. Major emphasis is on (1) the business firm as a part of a complex socio-economic system; (2) the effects of government, labor unions, and political, religious, and business organizations on the executive's decision problems; (3) environmental factors conducive to organizational change; and (4) organizational growth. ¾ unit. Prerequisite: Business Administration 511.

513. Seminar in Organization Theory. This course examines the major types of organization theory. Use of organization theory to guide research and to make business decisions; examination of major research methods used to study business organizations. ¾ unit. Prerequisite: Business Administration 512.

520. Marketing. An introductory analysis of the marketing system, its operations, and the mechanisms for coordinating these operations. The relationships of the firm to other firms and other institutions in the marketing system are studied, and the effects that such relationships have on the nature of decision problems of the individual business are analyzed. The firm's problem in developing an integrated marketing program, and the specific problem areas of price, channel, location, sales, and market development are discussed. ¾ unit. Prerequisite: Enrollment in a graduate program.

522. Quantitative Analysis for Marketing Decisions. The development of analytic quantitative models of various aspects of the firm's marketing environment and of models of marketing decision problems is studied. The course also involves a study of the ways in which such models can be used as a basis for making marketing decisions. Topics include market measurement, estimation of various kinds of market data, identification of the relationships between marketing variables, and forecasting. ¾ unit. Prerequisite: Business Administration 520 or equivalent.

524. Market Development. Communication from manufacturers and middlemen to consumer and industrial users, and from manufacturers to middlemen, is an essential element in the marketing process. The course deals with management of the several components of the market communication function including personal selling, advertising, sales promotion, and some marketing aspects of public relations activities for both consumer and industrial goods. Management of the market communication function is studied through cases dealing with (1) determining market communications goals and policies; (2) creating an organization to perform the market communication function; (3) planning market communication operations, including problems such as planning a sales campaign, selecting advertising media, setting standards and coordinating advertising with personal selling, and dealer promotions; (4) stimulating personnel and controlling execution of the plans; and (5) evaluating results obtained from specific selling activities. ¾ unit. Prerequisite: Business Administration 522 or equivalent.

525. Product Management. This course deals with the decisions on the firm's total market offer, including such topics as (1) use of market analysis in making decisions on assortment, product development, pricing, packaging, branding, and sales forecasting, and

(2) coordination of these decisions and actions with market communications, physical movement, production, finance, and the over-all goals and policies of the firm. The use of analytic and research methods in making assortment and product decisions is emphasized. ¾ unit. Prerequisite: Business Administration 522 or equivalent.

527. **Seminar in Marketing Theory and Policy.** This seminar is designed to study theories relating to the marketing system and the role of the individual business firm within that system. Marketing policy problems are discussed within the framework of various aspects of the firm's environmental circumstances. Marketing planning and decision-making processes covered include those involved in choice of policy concerning the marketing mix, price and product strategy, market development, and social and governmental relations. ¾ unit. Prerequisite: Business Administration 524 or 525.

531. **Introduction to Production.** An introductory course in decision-making problems in production. The course includes the theoretical foundations for production management as well as the applications of decision-making techniques to production problems in the firm. In particular, production processes, plant layout, maintenance, scheduling, quality control, and production control are considered. ¾ unit. Prerequisite: First semester of the M.B.A. program.

532. **Production Planning and Control.** Decision-making topics in production at the factory manager level and above are treated in depth. Topics include the development of generalized decision rules and systems analysis in production. In particular, the design of production control, quality control, and inventory control systems are stressed, and each of these systems is integrated into the firms as a whole. ¾ unit. Prerequisite: First year of the M.B.A. program.

533. **Quantitative Techniques in Production.** An advanced course in the application of quantitative techniques to decision-making problems dealing with production in the firm. Topics include structural estimation of production systems, application of operations research techniques to production problems, and computer simulation of decision systems. ¾ unit. Prerequisite: Business Administration 532 or equivalent.

540. **Written Analysis, I.** To develop the student's ability in writing reports based upon analysis of cases and the conclusions reached, this course has a threefold objective: (1) to improve the student's capacity to express himself effectively and efficiently in writing; (2) to contribute to the sharpening of his analytic skills; and (3) to help him integrate the knowledge learned in the functional fields. ½ unit. Prerequisite: Enrollment in a graduate program.

541. **Written Analysis, II.** The first part of this course is devoted to the scientific method of inquiry and specific research techniques. The purpose is to study both elements of basic logic and research procedures in order to help the student evaluate the reliability of data and validity of conclusions contained in business reports. The second part of the course is devoted to a major field study. Each student develops a solution to a business problem and presents an oral and written report of the solution to both the faculty and the businessmen concerned. ½ unit. Prerequisite: Business Administration 540 or equivalent.

542. **Business and Society.** The position of the business enterprise as an institution in American society; the role of the businessman in that society. ¾ unit. Prerequisite: Completion of the first year of the M.B.A. program or equivalent.

543. **Legal Problems of Business Management.** Past and current development of the legal climate in which business operates and in which managerial decisions are made; growth of the common law with its system of courts and procedure for law enforcement; the law of contracts, including various devices available for protection of creditors; legal problems involved in selecting a form of business organization. Students analyze business problems to see the importance of proper applications of the law to managerial decisions in regard to business policies. ¾ unit. Prerequisite: Completion of the first year of the M.B.A. program or equivalent.

544. **Executive Policies and Planning.** A course on policy construction at the executive level and the planning aspects of policy implementation. Builds a general management

point of view. Study of company-wide situations from the vantage point of the chief executive. Case method study with supporting readings. Develops integration and application of the subject matter of prior courses. 1 unit. Prerequisite: Completion of the first year of the M.B.A. program or equivalent.

545. Business Logistics. Movement, distribution, and control of raw materials and finished goods; site selection for manufacturing, warehousing, and distribution facilities; transportation media, selection, inventory control, communications networks, and requirements for logistics control data. Emphasis is on developing an integrated logistics system for a company. ¾ unit. Prerequisite: Enrollment in second year of the M.B.A. program or consent of instructor.

551. Financial Analysis. An introduction to the subject of managerial finance, with emphasis, on basic decisions of management and provision of capital resources. Techniques of profit planning and forecasting, evaluation of financial performance relative to control standards, and development of criteria for commitment of funds are stressed. ¾ unit. Prerequisite: First semester of the M.B.A. program.

552. Financial Management and Control, I. An analysis of the tools and techniques of capital expenditure management, with emphasis on the relation of financial forecasting and control to criteria for investment planning and asset management. The theory of investment is examined, as well as the relation of organizational structure to capital planning policy. ¾ unit. Prerequisite: Business Administration 551.

553. Financial Management and Control, II. An analysis of the problems confronting corporate financial management in deciding appropriate methods of financing capital expenditure commitments. A thorough analysis of the specialized literature, coupled with the use of selected case material, forms the core of the course. ¾ unit. Prerequisite: Business Administration 552.

554. Financial Theory and Policy. Special problems of economic analysis and their relation to the functional discipline of managerial finance; includes study of techniques for forecasting financial requirements under uncertainty, problems of income determination, the relation of long-term capital commitments to uncertain payoff vectors, internal and external capital rationing, and problems of identifying capital supply functions. ¾ unit. Prerequisite: Business Administration 553, 573, and 576.

555. Risk Management and Control. Same as Finance 470. An analysis of the risk management problem in the business enterprise with emphasis on methodology for risk analyses, techniques for risk and loss control, models for risk management decision-making, and procedures for administering risk management policy relating to non-speculative (insurable) risk. 1 unit. Prerequisite: Business Administration 552 and 560, their equivalents, or consent of instructor.

557. Seminar in Finance. Analysis of (1) financial policies and problems connected with corporate expansion through acquisition of interest in, or absorption of, established concerns including an examination of the legal, economic, and financial background for business combination, or (2) specific problems of financial management in light of differing operating characteristics of major enterprise classifications, including opportunities for students to construct decision models for application to problems of financial management. ¾ unit. Prerequisite: Business Administration 554 and573.

560. Managerial Accounting and Control. An analysis of managerial controls, the information needed for their operation, and the manner in which accounting provides that information; emphasis upon accounting as a tool of management. Problems and cases stress the type of figure information relevant to managerial decisions, and the methods of using such data. ¾ unit. Prerequisite: Enrollment in a graduate program.

562. Industrial Cost Control. A study of cost accounting, with emphasis on the use of operating data by management for control purposes. Methods of material pricing, labor costs, including fringe benefits; indirect manufacturing costs, direct costing, standard costs; estimated and statistical costs; distribution costs; contribution to overhead theory; depreciation and replacement of equipment; selection of plant; decision to

make or buy; relation between costs and pricing policy. 3/4 unit. Prerequisite: Business Administration 560 or equivalent.

563. Controllership. The controller in the business organization: his property control responsibilities; internal check; internal audits; insurance; his assistance to operating management through budgeting, break-even analysis, profitability studies; his relationship with groups outside of management such as investors and government agencies; emphasis on manner in which figure function of controller is used to integrate the operations of the business enterprise. 3/4 unit. Prerequisite: Business Administration 562 or equivalent.

570. Mathematical Analysis for Business Decisions. The use of classical mathematics in business decision-making; development of the concepts of total and marginal value analysis. Special emphasis is placed on the construction of quantitative models of business and economic systems, topics in bivariate and multivariate functions, differentiations, and integration. 3/4 unit. Prerequisite: Enrollment in a graduate program.

572. Modern and Classical Statistics for Business Decisions. The application of classical and modern statistics for business decision-making; topics in probability distributions, variance analysis, and partial and multiple correlation analysis as well as the use of personal probabilities and utility theory. 3/4 unit. Prerequisite: Enrollment in a graduate program.

573. Introduction to Operations Research. An introduction to operations research techniques; topics in integer, nonlinear, and dynamic programming, queueing theory, replacement, and Monte Carlo techniques; special projects in game theory applications in business. 3/4 unit. Prerequisite: Business Administration 572; completion of first year of the M.B.A. program.

574. Application of Operations Research Techniques. The application of the operations research techniques developed in Business Administration 573 to practical business problems. Most of the semester is devoted to a series of field research studies. Prior to the field studies, a review of previous work in the field is made. The role of the computer in solving operations research problems, as well as its application to the field research, is also a major consideration. 3/4 unit. Prerequisite: Business Administration 573.

575. Business Simulation. An introduction to the use of computers in solving business problems. Topics include the relation of integrated data processing systems to information flows within the firm and the development of simulation models of intrafirm decision processes. 3/4 unit. Prerequisite: Business Administration 573.

576. Business Forecasting and Econometrics. An introduction to maximum likelihood estimating techniques. Topics include the use and limitations of least squares, two-stage least squares, limited-information and full-information estimates. Problems with observational errors, multi-colinearity, and auto-correlation in time-series and cross-section structural estimation are considered. A major portion of the course is devoted to the application of the econometric techniques in business forecasting and analysis. 3/4 unit. Prerequisite: Business Administration 572.

577. Economics of Decision Making. The operational analysis of the problems of individual decisions under uncertainty that arise in the practice of management. 3/4 unit. Prerequisite: Business Administration. 572.

578. Stochastic Models in Management Science. The application of Markov processes to describe, analyze, and design systems of interest in management science, including queues, inventory, production, brand loyalty, stock market, and other applications. 1 unit. Prerequisite: Mathematics 361 or 363, or equivalent.

579. Mathematical Programming for Management Science. Mathematical programming models (linear, integer, quadratic, nonlinear, dynamic, and combinatorial) are used to describe, analyze, and design systems such as production, transportation, scheduling, and planning. 1 unit. Prerequisite: Mathematics 315 or equivalent.

582. International Business Operations, I. An integration of economics and the functional areas of business focused on the problems of managing international business operations. Economic, legal, functional, and administrative problems are studied

through cases and literature emphasizing financial and marketing problems. Student select one of Europe, Latin America, Africa, Middle and Near East, or South Asia and Far East, for special study and reporting. 3/4 unit. Prerequisite: Completion of first year of the M.B.A. program.

583. International Business Operations, II. Continuation of Business Administration 582. 3/4 unit. Prerequisite: Business Administration 582.

590. Independent Study and Research. Directed reading and research. 1/2 or 1 unit.

599. Thesis Research. Individual direction of research and thesis writing. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. The Law of the Uniform Commercial Code. (Formerly Industrial Administration 301.) A continuation of the private law of business dealing with significant phases of the law of commercial transactions under the Uniform Commercial Code—sales, commercial paper, bank collections and deposits, bulk transfers, and security devices. Also included is the law of bailments, suretyship, and security in real property. 3/4 or 1 unit. Prerequisite: Business Administration 201 or 261.

302. Wills, Estates, and Trusts. (Formerly Industrial Administration 302. A study of the basic legal and management principles and practices involved in the planning and administration of wills, estates, and trusts. 3/4 or 1 unit. Prerequisite: Business Administration 200, 201, or 261.

311. Administrative Policies and Organization. (Formerly Industrial Administration 311.) Development of administrative organization and the determination of policies for the integration of major activities of a business enterprise. 1/2 or 3/4 unit. Prerequisite: Business Administration 202 and 210.

315. Management in Manufacturing. (Formerly Industrial Administration 315.) The application of production concepts and quantitative techniques to actual industrial problems; the mathematical structure of the particular production problems and the general structure of the production system and its interaction with marketing and budgeting. Areas include inventory control, production processes, programming and production control, forecasting of production levels, simulation of the production system, and physical planning of industrial plants. 1/2 unit. Prerequisite: Business Administration 213.

320. Marketing Research. (Formerly Marketing 320.) An investigation of the development and applicability of information systems techniques to marketing problems. The marketing management process is analyzed; the underlying concepts related to the information needed to serve the processes are explored; and the incorporation of information resources into the management function is demonstrated. This course covers the use of behavioral sciences research methods, social processes and structure influences upon marketing activities, demographic variables, application of Bayesian decision theory, studies of promotional activity, simulation and programming models, planning models, and strategy formulation models which provide an analytical structure for the solution of marketing problems. 1/2 unit. Prerequisite: Business Administration 202.

321. Industrial Social Systems, I. (Formerly Industrial Administration 321.) Same as Labor and Industrial Relations 321. Particular forms of individual and group behavior in organizations within the constraints of the economic, social, technological, and physical environment; the relations between union and management; the interdependency of these factors with the decisions managers make. 1/2 to 1 unit. Prerequisite: Business Administration 210; Psychology 100; Psychology 201 or consent of instructor.

323. Industrial Social Systems, II. (Formerly Industrial Administration 323.) Understanding of complex organizations; particular attention to ways of dividing work, achieving coordination, and issues connected with change and adaptation. 1/2 to 1 unit. Prerequisite: Business Administration 321; Psychology 201.

337. Advertising and Sales Management. (Formerly Marketing 337.) Designed to enable the student, through directed and supervised investigation of selected psychological, economic, and sociological problems, to become acquainted with the methods of demand analysis and its application to the interrelationships of marketing management, advertising management, and sales management. Discussion of communication theory as it relates to the goals and means of winning patronage for the firm. Emphasis in on the effect, or control, of the communication process. Class discussion is focused upon literature in demand stimulation and communications and the testing of relevant hypotheses. ½ unit. Prerequisite: Business Administration 202.

344. Consumer Market Behavior. (Formerly Marketing 344.) An analysis of consumer motivation, buying behavior, market adjustment, and product innovation, including a survey of explanatory theories of consumer market behavior and producer reactions. This course covers behavioral aspects of the marketing process from the producer to ultimate user, or consumer. Fundamentals of product planning, development, engineering, and promotion are viewed as part of the total marketing program. Normative models of the decision-making process for winning patronage in intermediate, industrial, and consumer markets are considered. The decision-making process by consumers is evaluated with reference to psychological drives used by producers, middlemen, and consumers. ½ unit. Prerequisite: Business Administration 202.

351. Personnel Administration. (Formerly Industrial Administration 351.) A study of concepts and methods used by the staff personnel unit in building and maintaining an effective work force in an industrial organization; development of ability to design the personnel subsystem within the firm and to deal effectively with problems encountered in such areas as recruitment, selection, training, and wage and salary administration; considerable emphasis upon case analysis, role playing, and research. ½ to 1 unit. Credit is not given for Business Administration 351 and Psychology 145 or 245 and Business Administration 448 or 449. Prerequisite: Business Administration 323; Economics 173 and 240.

352. Pricing Policies. (Formerly Marketing 352.) The essential nature of marketing decisions and pricing, marketing organization and the pricing process, price theories and pricing models; contributions of operations research and behavioral sciences to pricing analysis; the relationship of pricing objectives, methods, strategies, and policies to market behavior and the goals of the firm. ½ unit. Prerequisite: Business Administration 202.

353. Industrial Relations Administration. (Formerly Industrial Administration 353.) An investigation of union-management relations primarily at the company level for those planning careers in the industrial labor relations field; topics include grievance handling, disciplinary policies and procedures, arbitration and contract negotiations; emphasis is given to case study and role playing techniques. ½ to 1 unit. Credit is not given for both Business Administration 353 and Business Administration 448 or 449. Prerequisite: Business Administration 323; Economics 240.

360. Marketing Logistics. (Formerly Marketing 360.) The ecology, analysis, and development of integrated distribution systems; the application of quantitative tools, economic analysis, transportation and marketing management in the analysis, and interpretation and design of the physical flow of goods through marketing network alternatives. Attention is given to the theory of market structures, transport networks, location, and cost control. Consideration is also given to site selection, warehousing, inventory management, logistic communications networks, and data control models. ½ unit. Prerequisite: Business Administration 202.

370. International Marketing. (Formerly Marketing 370.) The role of enterprise, comparative marketing, and transport institutions and systems, and comparative marketing organizations and systems of administration in selected foreign countries and the United States; the managerial and operational problems of world enterprise, with emphasis on the role of ethnic and cultural differences in influencing marketing strategy. ½ unit. Prerequisite: Business Administration 202; consent of instructor.

373. Electronic Data Processing for Business. A course in the fundamentals of business data processing. The use of modern electronic computers in the areas of accountancy, economics, management, marketing, and general business is considered. The facilities of the Digital Computer Laboratory are utilized in the course. ½ or 1 unit. Prerequisite: Economics 170; Accountancy 166 or 108.

374. Operations Research. Introduction to methods of operations research from an executive or managerial viewpoint, emphasizing formulation of business problems in quantitative terms. Industrial applications of linear programming and dynamic programming, game theory, probability theory, queueing theory, and inventory theory. ½ or 1 unit. Prerequisite: Economics 173 and Business Administration 210, or consent of instructor.

380. Advanced Marketing Management. (Formerly Marketing 380.) The appraisal and diagnosis, organization and planning, action and control of commodity and product-service distribution, marketing analysis and systems, and demand stimulation; a survey of normative models for decision-making in a variety of marketing situations and systems; introduction to the behavioral theory of the firm and its application to different marketing targets, institutional settings, or market arrangements; discussion of the various analytical tools available to firms for appraising, diagnosing, organizing, planning, and formulating market strategies. Principles of behavioral sciences and quantitative techniques are emphasized. A terminal course that integrates the analysis of a wide range of marketing problems and situations. ½ unit. Prerequisite: Business Administration 320 and 337.

CATALAN

See descriptions and course listings under Spanish, Italian, and Portuguese, page 375.

CERAMIC ENGINEERING

The Department of Ceramic Engineering offers work leading to the Master of Science and Doctor of Philosophy in Ceramics or in Ceramic Engineering. The prerequisite for graduate study in these areas is proficiency in the undergraduate courses required for the Bachelor of Science in Ceramic Engineering at the University of Illinois, or acceptable equivalents.

A minimum grade-point average of 3.75 for the last sixty hours of undergraduate work is required for admission. Students with grade-point averages between 3.75 and 4.0 are considered on an individual basis. Students who have bachelor's degrees in chemistry, physics, geology, or engineering may become candidates in this department.

A candidate for the Master of Science in Ceramics or Ceramic Engineering must complete a minimum of eight units of graduate work including a thesis.

Candidates for the Doctor of Philosophy in Ceramics must present the equivalent of the courses in chemistry, mathematics, physics, and ceramics listed in the undergraduate engineering curriculum.

Candidates for the Doctor of Philosophy in Ceramics or Ceramic Engineering are required to complete first the M.S. thesis (or give equivalent evidence of research); they must also pass the departmental qualifying examination.

Minors selected by graduate students in ceramics or ceramic engineering are chemistry, physics, mathematics, geology, or other engineering disciplines.

Students majoring in chemistry, physics, engineering, and other departments may take sole or second minors in ceramics or ceramic engineering. A second minor requires no ceramics prerequisite.

FACULTY

Professors: A. L. Friedberg (Head of Department), A. W. Allen, C. G. Bergeron, R. L. Cook, J. A. Nelson, F. V. Tooley, W. S. Williams.
Associate Professors: S. D. Brown, T. A. Willmore.
Assistant Professor: G. P. Wirtz.

COURSES FOR GRADUATES

401. Ceramic Chemistry. Silica, silicates, fusions, and phase relations. 1 unit. Prerequisite: Courses in chemistry and physics.

402. Ceramics. Chemical and physical phenomena. 1 to 2 units. Prerequisite: Courses in physics and chemistry.

405. Glass Technology. This course, following a brief review of unit processes and operations in glass manufacture, treats from a dominantly theoretical and research point of view selected major topics relating to the glass preparation process and the chemical, mechanical, optical, and electrical properties of glass. $\frac{3}{4}$ or 1 unit; for students electing the course for 1 unit, extra contact hours are arranged. Prerequisite: Ceramic Engineering 301 or equivalent, or consent of instructor. Tooley.

406. Glass Technology. This course is dominantly theoretical in approach. Following a survey of the basic theoretical ideas that have been used in the development of the glass model, student readings and reports from the classical and modern literature serve as the basis of class discussions on glass structure and behavior, with emphasis on structure property correlations. $\frac{3}{4}$ or 1 unit; for students electing the course for 1 unit, extra contact hours are arranged. Prerequisite: Ceramic Engineering 405 or consent of instructor.

407. Porcelain Enamels. This course covers the fundamental scientific principles involved in the area of porcelain enameling and the properties of such coatings. 1 or $1\frac{1}{2}$ units (includes laboratory if taken for more than 1 unit). Prerequisite: Ceramic Engineering 222 and 320, or equivalent.

409. Whitewares. Advanced study in the field of whitewares, including fundamental considerations of glazes and all types of ceramic bodies. Special emphasis is placed on new developments in research and processing. Considerable attention is given to the ferroelectric and ferromagnetic properties of electronic ceramics. 1 or $1\frac{1}{2}$ units (includes laboratory if taken for more than 1 unit). Prerequisite: Ceramic Engineering 309; Ceramic Engineering 340 or equivalent. Cook.

410. Dielectric Properties of Ceramic Materials. Fundamental properties of vector fields are reviewed. The reaction of insulating solids to external electric fields is considered in terms of dielectric theory. The properties of ceramic dielectrics including ferroelectrics are treated in terms of present theory. The piezoelectric properties of ferroelectric crystals and ceramics are correlated with the crystal structure, microstructure, and the ferroelectric properties. $\frac{3}{4}$ or 1 unit; for students electing the course for 1 unit, extra contact hours are arranged. Prerequisite: Mathematics 345 and 343, or consent of instructor. Wirtz.

412. Structural Physical Ceramics. Structural chemistry and crystallization behavior of ceramic systems at elevated temperatures; nucleation, crystal growth; mineral synthesis; high-temperature reaction kinetics, including phase transformations and diffusion. $\frac{3}{4}$ or 1 unit; for students electing the course for 1 unit, extra contact hours are arranged. Brown.

414. Physical Chemistry of Clays and Soils. Same as Agronomy and Mining Engineering 414. The application of physical chemical principles and concepts to surfaces and adsorption on surfaces. Silicate surfaces and water adsorption are emphasized. 1 unit. Offered in 1970-1971 and in alternate years. Prerequisite: Chemistry 340 and 341, or equivalent, or consent of instructor. R. J. Miller.

418. Physics of Strong Solids. Characterization and interpretation of physical properti of single-phase and composite materials of high strength: covalently-bonded sem conductors; transition-metal carbides, borides and nitrides; graphite; glass; fiber precipitation-hardened metals. 1 unit. Prerequisite: Any one of the following: Ceram Engineering 307 or 421, Metallurgical Engineering 384, Chemistry 342, Physics 490, c consent of instructor. WILLIAMS.

421. Refractory Materials Engineering. The interpretation of the behavior of materia for utilization in an environment where high-temperature structural stability and contr of thermal energy transport are the prime considerations. Design and material selectio criteria based on thermal energy control, mechanical stress response, and structur integrity at elevated temperature are emphasized. 1 unit. Prerequisite: Ceramic Eng neering 310 or consent of instructor. ALLEN.

422. High-Temperature Technology Laboratory. Laboratory to accompany Cerami Engineering 421, with emphasis on instrumentation for and measurement of propertie at elevated temperature. Analytical interpretation of data in numerical problems is in cluded, ½ unit. Prerequisite: Credit or registration in Ceramic Engineering 421, o consent of instructor. ALLEN.

461. Mineralogy of Clays. Same as Geology 461. The composition of various types of clays the structure and properties of the clay minerals; the origin and mode of occurrence o the clay minerals and clay materials. 1 unit. Prerequisite: Geology 336 or Chemistr 328, or equivalent; consent of instructor.

462. Mineralogy of Clays. Same as Geology 462. The properties of clay materials, thei relation to the structure of the clay minerals, methods of determination and control the utilization of clays in various arts and industries. 1 unit. Prerequisite: Geology 461.

495. Materials and Special Problems. Conference and laboratory. 0 to 2 units.

498. Seminar in Ceramics. Lectures on current ceramic research and development Presentations by visiting lecturers as well as graduate students and staff in the depart ment. Registration required of all graduate students in ceramic engineering. Graduate students nearing completion of their theses are required to make a seminar presentation. No credit. Prerequisite: Graduate standing in ceramic engineering.

499. Thesis Research. Research in any of the branches of ceramics. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Advanced Chemistry and Technology of Glass. This course augments some of the subject matter of Ceramic Engineering 214, and develops additional subject matter relating to the theory of glass formation and structure and the behavior of glass as a function of composition, structure, and heat treatment. Students taking this course gain improved qualifications for research work in the field. ½ unit. Prerequisite: Ceramic Engineering 214 or consent of instructor. TOOLEY.

307. Thermal and Mechanical Properties of Ceramic Materials. Interpretations of the thermal and mechanical behavior of real ceramic materials utilizing the atomistic concepts of structure correlated with characterized microstructure. Half of the course treats the mechanism of thermal dilatation, heat transport and emission. The remainder integrates the characterization of deformation including elastic, anelastic, plastic, and viscous behavior. Temperature dependency is stressed throughout. Lectures and laboratory. ¾ unit. Prerequisite: Ceramic Engineering 216, 331, or equivalent; Theoretical and Applied Mechanics 154 and 221. BROWN.

309. Whiteware Materials. A study of the characteristics and engineering properties of multi-phase polycrystalline aggregates and vitreous complexes including the raw material preparation, fabrication, and processing. Special emphasis is placed on the single and multi-oxide component bodies, including the crystallographic structures of the alkaline earth titanates and the ferritic spinels as whiteware materials. ¾ unit. Prerequisite: Ceramic Engineering 216 or equivalent. COOK.

310. Refractory Technology. A study of the engineering properties and thermochemistry of polycrystalline materials for use at elevated temperatures, including processing of raw materials, the manufacture, heat treatment, quality control, and specification of refractory products. Particular emphasis is placed on oxides, silicates, carbides, borides, cermets, and refractory metals, with a correlation of the properties of those materials to certain design criteria. $^3/_4$ or 1 unit (includes laboratory if taken for 1 unit). Prerequisite: Ceramic Engineering 307. ALLEN.

311. Ceramic X-Ray Analysis. The use of x-ray diffraction for phase identification, for the determination of crystalline lattice parameters, and for the determination of the thermal expansion of crystalline solids is discussed; analytical methods of indexing powder diffraction patterns are covered; the determination of precise lattice parameters by means of computer programming and high temperature x-ray techniques is reviewed. $^3/_4$ unit. Prerequisite: Mathematics 195; senior standing in the departments of Engineering, Chemistry and Chemical Engineering, or Geology, or consent of instructor. WIRTZ.

320. Advanced Porcelain Enamels. An advanced study of the field of porcelain enamels with particular emphasis on fundamentals of bond or adherence of enamel metal systems, on opacity and mechanism of color development and measurement, and on the thermal and chemical properties of coatings on metal. Specific attention is given to coatings for use on metals at elevated temperatures. $^1/_2$ or $^3/_4$ unit. Prerequisite: Ceramic Engineering 222 or consent of instructor. COOK.

331. Ceramic Microscopy. A study of the optical activity in isotropic and anisotropic media with particular emphasis on the materials and products of ceramics; the application of these principles and related topics of optical microscopy to the study of the morphology, aggregation, size, and microstructure of the products of high-temperature thermochemical reactions and equilibria. $^3/_4$ or 1 unit (includes studies in thermal microscopy if taken for 1 unit). Prerequisite: Ceramic Engineering 205 and 216, or consent of instructor. ALLEN.

340. Electrical Ceramics. The subject of dielectric crystals and their electrical properties is presented; the ferroelectric and piezoelectric properties of several crystal classes are discussed and correlated; the perovskite class of ferroelectric compounds is covered in detail; spinel, garnet, and hexagonal type ferrimagnetic crystals and their properties are discussed. $^3/_4$ unit. Prerequisite: Ceramic Engineering 309 or consent of instructor.

388. Nuclear Ceramics. A study of the characterization, behavior, and utilization of ceramic materials for the radiation environment of modern nuclear reactor devices with particular emphasis on the power reactor. Material functions in radiation environment, the ceramic nuclear fuel cycle, radiation damage in non-fissile ceramics, nuclear carbon and graphite and non-fuel ceramic isotope utilization are discussed. 1 unit. Prerequisite: Chemistry 245, Physics 383, or consent of instructor. ALLEN.

CHEMICAL PHYSICS

Fundamental research on many properties of molecular and solid state systems is based on an understanding of chemistry, physics, and mathematics that can best be obtained by training in more than one department of the University. A program leading to the Doctor of Philosophy in Chemical Physics makes it possible for students to gain the necessary background and perform original research in this interdisciplinary field of science.

Applicants for admission should have undergraduate degrees in chemistry or physics, a grade-point average of at least 4.0, and a strong background in the major field of chemistry or physics, with more than the usual training in the other area. Those who received their degrees in physics should have the equivalent of one semester each of organic and inorganic chemistry and one year of physical chemistry. Those who received their degrees in chemistry should have the equivalent of one semester each of intermediate mechanics and intermediate electricity and magnetism. One year of mathematics beyond calculus is recommended. Deficiencies should be removed during the first year of study.

In addition to satisfying the requirements of the Graduate College, students must pass either the qualifying examination in the Department of Physics or the set of cumulative examinations given by the Division of Physical Chemistry. A knowledge of the content of Chemistry 348 and 349 or Physics 362 and 381 must be demonstrated also (for example, by passing the final examinations in these courses).

Research for the dissertation is performed under the direction of staff members who are currently active in chemical physics. Students may apply for fellowships and assistantships and may make use of the facilities available in the departments of Chemistry and Chemical Engineering and Physics.

Students with undergraduate degrees in chemistry should direct inquiries and applications to the head of the Department of Chemistry and Chemical Engineering; students with undergraduate degrees in physics should direct inquiries and applications to the head of the Department of Physics.

CHEMISTRY AND CHEMICAL ENGINEERING
(Including Biochemistry)

The degrees offered in chemistry and chemical engineering are Master of Arts or Master of Science in Chemistry, Master of Science in Chemical Engineering, and Doctor of Philosophy in Chemistry or in Chemical Engineering. The courses offered in biochemistry and in chemical engineering are listed separately following those in chemistry. Attention is also called to a joint program leading to the Doctor of Philosophy in Chemical Physics (see page 115) and to the program in biophysical chemistry (see pages 101, 117, and 263).

Students who have fulfilled the usual undergraduate course requirements, including at least twenty-five semester hours in chemistry properly distributed, and who have a grade-point average of 4.0 or above, may apply for admission to the Graduate College in chemistry or chemical engineering. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

Students who have completed graduate work in chemistry or chemical engineering at another institution may be admitted if they have grade-point averages of 4.0 in both undergraduate and graduate work, of if they have earned a 4.25 average in at least eight units or a full year of graduate work at an accredited institution.

Graduate students whose major subject in the Graduate College is in a department other than Chemistry and Chemical Engineering may take chemistry courses for graduate credit if they have had the equivalent of fifteen semester hours of chemistry. Such students are advised to consult members of the staff in choosing courses appropriate to their backgrounds and objectives.

THE TEACHING OF CHEMISTRY

Candidates for the Master of Science in the Teaching of Chemistry must earn four units in chemistry, two units in education, and two units of electives in either education or physical science. The two units in education consist of the following courses: History and Philosophy of Education 304 and 305, and Educational Psychology 311 and 312. The courses in chemistry and the electives, which must normally give graduate credit, must be selected with the approval of the adviser. Students applying for admission must have a grade-point average of at least 3.5. Inquiries concerning this program should be directed to Professor D. H. Secrest, 155 Noyes Laboratory.

BIOCHEMISTRY

The Biochemistry Division of the Department of Chemistry and Chemical Engineering administers the graduate program in biochemistry. The curriculum is composed of Biochemistry 350, 355, 450, 452, and 494, and selected offerings in allied chemical and biological areas. Interested students should direct inquiries and applications to the head of the Biochemistry Division.

BIOPHYSICAL CHEMISTRY (MOLECULAR BIOLOGY)

The Department of Chemistry and Chemical Engineering offers an area of specialization in biophysical chemistry. The program is flexible and provides the student with basic training in physical chemistry, physical biochemistry, and biology. Students electing this area should have a solid background in physics and mathematics. Details of the curriculum are decided individually. Interested students should direct inquiries and applications to the head of the Department of Chemistry and Chemical Engineering.

CHEMICAL ENGINEERING

Candidates for advanced degrees in chemical engineering should have had undergraduate training comparable to that offered in the undergraduate chemical engineering curriculum at the University of Illinois. Students who enter without the usual engineering courses are required to make up their deficiencies to the extent prescribed by their adviser. Candidates for the Master of Science must include two chemical engineering courses at the 400 level in their programs. Interested students should direct inquiries and applications to the head of the Chemical Engineering Division.

FACULTY

Professors: H. S. Gutowsky (Head of Department), D. E. Applequist, J. C. Bailar, Jr., T. L. Brown, H. E. Carter, D. Y. Curtin (Associate Head of Department), R. S. Drago, H. G. Drickamer, W. H. Flygare, J. Gorski, I. C. Gunsalus, L. P. Hager, G. P. Haight, Jr., T. J. Hanratty, J. P. Hummel, H. A. Laitinen, N. J. Leonard, H. V. Malmstadt, R. A. Marcus, J. C. Martin, R. F. Nystrom, J. A. Quinn, K. L. Rinehart, H. R. Snyder, G. Weber, J. W. Westwater, P. E. Yankwich.

Associate Professors: P. Beak, R. L. Belford, J. M. Clark, Jr., H. E. Conrad, C. A. Eckert, A. M. Hartley, J. L. Hudson, G. J. Schroepfer, Jr., D. H. Secrest, S. G. Smith, G. D. Stucky.

Assistant Professors: R. C. Alkire, E. K. Barefield, J. K. Beattie, R. M. Coates, K. M. Dus, W. T. Ford, C. D. O. Foster, J. R. Lombardi, J. A. Katzenellenbogen, W. O. McClure, R. L. Sani, R. L. Switzer, J. G. Wetmur, J. M. Wood, J. T. Yardley.

Chemistry

COURSES FOR GRADUATES

402. Inorganic Chemistry. The less familiar elements and their relationship in the periodic system. Lectures, reports, and assigned readings. 1 unit.

404. Advanced Inorganic Chemistry Laboratory. Specialized laboratory techniques; more difficult inorganic syntheses. $\frac{1}{4}$ to $\frac{3}{4}$ unit. Prerequisite: Credit or registration in one of the lecture courses in inorganic chemistry in the 400 series.

405. Inorganic Chemistry. Seminar. Required of all graduate students whose major is inorganic chemistry. $\frac{1}{4}$ unit.

406. Physical Inorganic Chemistry. Qualitative description of the bonding in inorganic compounds; use of physical methods to provide information about the structure and reactions of inorganic compounds; structures and reactions of inorganic compounds in solution. 1 unit. Prerequisite: Chemistry 315 and 344.

407. Special Topics in Inorganic Chemistry. An advanced course dealing with a subject not ordinarily covered by regularly scheduled courses, such as organo-metallic chemistry, advanced ligand field theory and molecular orbital theory of inorganic compounds, kinetics and mechanisms of inorganic reactions, etc. $\frac{1}{2}$ to 1 unit. Students may repeat this course for credit. Prerequisite: Chemistry 406, or consent of instructor.

408. The Chemistry of Complex Inorganic Compounds. The nature of the coordinate bond; applications of complex compounds. 1 unit. Prerequisite: Chemistry 315.

421. Spectrochemical Methods of Analysis. Emission spectroscopy; Raman spectroscopy; mass spectrometry; ultraviolet, visible, infrared, and microwave absorption spectroscopy; colorimetry, fluorimetry, interferometry, and polarimetry. Lectures and laboratory. 1 unit. Prerequisite: General physics and chemistry equivalent to a major for a bachelor's degree.

422. Electrical Methods of Chemical Analysis. Polarography, potentiometric, amperometric, conductometric titrations, and other selected topics. Lectures and laboratory. 1 unit. Prerequisite: Chemistry 344 or equivalent.

423. Electron Microscopy. Same as Biology 423. Lectures, discussions, and demonstrations on the physical principles and electron optics of the transmission of electron microscopes and its modern variants, including lectures and demonstrations of modern high vacuum techniques. Open to qualified graduate students in all departments. $\frac{1}{2}$ unit. Prerequisite: A course in modern physics or physical chemistry (having calculus as a prerequisite) affording an introduction to wave mechanics; consent of instructor.

424. Quantitative Analysis. Advanced principles, including chemical statistics, calculations, experimental methods, and applications. $\frac{1}{2}$ unit.

425. Analytical Chemistry. Seminar. Required of all graduate students whose major is analytical chemistry. $\frac{1}{4}$ unit.

427. Applied X Rays: Crystallography. Lectures. $\frac{3}{4}$ unit. Prerequisite: Training in physics and physical chemistry.

429. Electron Microscopy with Laboratory. Same as Biology 429. General lectures on theory and design of electron microscopes without mathematical derivations; discussion and practice on specimen preparation; operation of electron microscopes with separate sections to meet special needs of biologists, geologists, and those interested in electron diffraction. (Most theory lectures may be omitted by those enrolled or having credit in Biology or Chemistry 423.) Open to qualified graduate students in all departments. 1 unit. Prerequisite: Two semesters of general physics, two semesters of college mathematics, and three semesters of chemistry; consent of instructor.

430. Organic Chemistry. Survey of organic chemistry for graduate students. 1 unit. Prerequisite: One year of organic chemistry.

431. Organic Chemistry. Advanced survey of organic chemistry with emphasis on reaction mechanisms and synthesis. 1 unit. Prerequisite: Chemistry 430 or 336; one year of physical chemistry.

432. Organic Chemistry. Advanced survey of organic chemistry with emphasis on structure. 1 unit. Prerequisite: Chemistry 431 or 336.

433. Organic Chemistry. Special topics in organic chemistry. An advanced course dealing with a subject not ordinarily covered by regularly scheduled courses, such as natural product synthesis and biosynthesis, organic photochemistry, chemistry of special families of organic compounds, etc. $\frac{1}{2}$ or $\frac{3}{4}$ unit; $\frac{3}{4}$ unit requires two lectures per week. Students may repeat this course for credit. Prerequisite: Chemistry 431 and 432, one of which may be taken concurrently.

434. Advanced Organic Synthesis. Lecture and laboratory. $\frac{1}{4}$ to 1 unit.

435. Organic Chemistry. Seminar. Current literature in organic chemistry. $\frac{1}{2}$ unit. Prerequisite: Consent of instructor.

436. Experimental Organic Chemistry. A lecture course on research techniques in organic chemistry. $\frac{1}{4}$ unit. Prerequisite: Consent of instructor.

441. Chemical Thermodynamics. Fundamental laws of thermodynamics and their molecular interpretation; determination and chemical use of thermodynamic quantities. 1 unit. Prerequisite: Chemistry 342 and 344, or equivalent.

442. Statistical Thermodynamics. Basic principles of classical and quantum statistics with applications to chemistry. 1 unit. Prerequisite: Chemistry 441 and 446, or consent of instructor.

443. Quantum Dynamics. The quantum mechanical description of time-dependent processes, including discussions of time-dependent Schrödinger equation, approximations, interaction of matter with radiation, wave packets, elastic and inelastic scattering, and relaxation phenomena. 1 unit. Prerequisite: Registration in Chemistry 349 or consent of instructor.

445. Physical Chemistry. Seminar. Required of all graduate students whose major is physical chemistry. $\frac{1}{4}$ or $\frac{1}{2}$ unit. Prerequisite: Consent of instructor.

446. Molecular Quantum Mechanics. The quantum mechanical description of atoms and molecules including discussions of angular momentum and group theory, approximate methods for the determination and interpretation of atomic and molecular wave functions, and the calculation of physical and chemical properties and spectra. 1 unit. Prerequisite: Registration in Chemistry 349 or consent of instructor.

448. Chemical Kinetics. Chemical reaction and theory of rate processes. Lectures. $\frac{3}{4}$ unit. Prerequisite: Chemistry 441 or consent of instructor.

449. Special Topics in Physical Chemistry. An advanced course dealing with a subject not ordinarily covered by regularly scheduled courses, such as molecular spectroscopy, statistical mechanics, radiation and hot-atom chemistry, molecular quantum mechanics, radiofrequency spectroscopy, advanced experimental methods, kinetics of irreversible processes and cooperative phenomena, etc. $\frac{1}{2}$ or 1 unit. Students may register for credit more than once. Prerequisite: Consent of instructor.

490. Special Topics in Chemistry. This course is designed for students majoring or minoring in chemistry who wish to undertake individual studies of a non-Ph.D. thesis nature, under the direction of a faculty member of the department. $\frac{1}{4}$ to 4 units. Prerequisite: Consent of instructor and of head of department. Staff for the course is the same as for Chemistry 499.

493. Advanced Electron Microscopy. Same as Biology 493. Conferences and practice dealing with specialized laboratory techniques, preparation of specimens, the analysis and study of varied materials by use of transmission and/or scanning electron microscopes and by the techniques of electron diffraction. Open to qualified students in all departments. $\frac{1}{4}$ to $\frac{1}{2}$ unit. Prerequisite: Credit in Biology or Chemistry 429; consent of instructor.

494. Chemical Basis of Biological Specificity. Same as Biochemistry 494. Biological formation and interaction of large molecules; analysis of the structural features concerned with functional specificity in heteropolymers, viruses, and subcellular particles; nucleic acids and their role as genetic molecules; proteins in their role as genetic products with highly specific functions; metabolic interrelations of these molecules. $\frac{3}{4}$ unit. Prerequisite: Chemistry 344 and 346, and Biochemistry 350 or 450; Microbiology 330; or consent of instructor.

496. The Use of Carbon-14 in Labeling Techniques. Same as Animal Science 496. A comprehensive study of the chemistry of carbon-14. The laboratory work deals with vacuum-line manipulations and synthesis, degradation, and assay of radioactive carbon compounds. $\frac{3}{4}$ or 1 unit. Prerequisite: Chemistry 336, 337, and 338, or equivalent; consent of instructor.

499. Thesis Research. A candidate for the master's degree who elects research is required to present a thesis in order to apply credit in Chemistry 499 toward meeting the requirements of the degree. A thesis is always required of students working toward the Doctor of Philosophy. Not all candidates for thesis work necessarily are accepted. 0 to 4 units. Work may be taken in any of a wide variety of fields, subject to the approval of an appropriate staff member who serves as the student's thesis adviser. Much of present research involves more than one of the traditional fields and student programs are planned

accordingly, often on a highly individual basis. Accordingly, the following listing of fields and staff is intended to be informative, but it is not all inclusive. Details with respect to the programs possible are available from the various staff concerned and also from the head of the Department of Chemistry and Chemical Engineering.

Analytical Chemistry. Hartley, Jonas, Juvet, Laitinen, Malmstadt, Rinehart

Biophysical Chemistry. Gunsalus, Leonard, Paul, Rinehart, Weber, Wetmur, Wood.

Inorganic Chemistry. Bailar, Barefield, Beattie, Brown, Drago, Haight, Stucky.

Organic Chemistry. Applequist, Beak, Coates, Curtin, Ford, Katzenellenbogen, Leonard, Martin, Paul, Pirkle, Rinehart, Schroepfer, Smith, Snyder.

Physical Chemistry and Chemical Physics. Belford, Drickamer, Flygare, Gutowsky, Hummel, Jonas, Lombardi, Marcus, Paul, Secrest, Wetmur, Yankwich, Yardley.

Radiochemistry. Hummel, Nystrom.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

315. Inorganic Chemistry. Nuclear and extranuclear atomic structures and their relation to the properties of the elements and their compounds; types of bonding; survey of the periodic relationships; preparation and applications of the elements and their compounds. $\frac{3}{4}$ unit. Prerequisite: Credit or registration in physical chemistry.

316. Inorganic Chemistry Laboratory. Preparation of typical inorganic compounds illustrating special and advanced techniques, including characterization by modern physical methods. $\frac{3}{4}$ unit. Prerequisite: Chemistry 383, or credit or registration in Chemistry 315, or equivalent.

321. Instrumental Analysis. Advanced instrumental methods of chemical analysis and their application to the study of chemical reactions. $\frac{3}{4}$ unit. Prerequisite: Chemistry 340 or 342, and 383.

322. Separation Methods and Quantitative Organic Analysis. Theory and practice of gas, liquid, ion-exchange, and gel permeation chromatography, countercurrent distribution, electrophoresis, and distillation; qualitative and quantitative interpretation of IR, mass, and NMR spectroscopy; quantitive methods of organic analysis via functional groups. 1 unit. Prerequisite: Chemistry 336.

323. Applied Electronics for Scientists. A lecture and laboratory course designed expressly for chemists and other scientists or engineers who have little or no background in electronics, but who need a working knowledge of electronic devices, circuits, and instruments. The course begins with electronic principles and leads systematically into digital, analog, and servo systems used in scientific instrumentation. 1 unit. Prerequisite: Consent of instructor.

336. Organic Chemistry. Second course. Lectures and recitations. $\frac{3}{4}$ unit. Prerequisite: Chemistry 131 and 134, or Chemistry 136 and 181.

337. Organic Chemistry. Laboratory experiments in organic chemistry. $\frac{1}{2}$ unit. Prerequisite: Credit or registration in Chemistry 336.

338. Separation, Purification, and Identification of Organic Compounds. Separation, purification, and identification of organic compounds using modern research methods; the identification of organic compounds by the use of spectroscopic methods and chemical conversion; the separation of mixtures and the purification of the components by crystallization, sublimation, distillation, extraction, and chromatography; the qualitative and quantitative identification of the components of a mixture. 1 unit. Prerequisite: Chemistry 336 and 337.

339. Theoretical Organic Chemistry. Theoretical interpretation of reactivity, reaction mechanisms, and the nature of common reaction intermediates: carbonium ions, free

radicals, and carbanions. 3/4 unit. Prerequisite: Chemistry 338 or consent of instructor.

340. **Principles of Physical Chemistry.** A one-semester course in physical chemistry emphasizing topics most important to students in the biological and agricultural sciences. Not open to students in the specialized curricula in chemistry or chemical engineering. 1 unit. Prerequisite: Physics 102; Chemistry 122 and 131, or equivalent; Mathematics 130 or equivalent.

341. **Elementary Physical Chemistry Laboratory.** A laboratory course to accompany Chemistry 340. 1/4 unit. Prerequisite: Registration in Chemistry 340 or credit for one semester of a lecture course in physical chemistry.

342. **Physical Chemistry.** This course and Chemistry 344 constitute a year-long study of chemical principles, covering topics such as: atomic and molecular structure, properties and thermodynamics of gases, liquids, crystals, phase equilibria, solutions, surface chemistry, chemical equilibrium, electrochemistry, chemical thermodynamics, and chemical kinetics. Students who do not intend to take Chemistry 344 should not enroll in Chemistry 342. 3/4 unit. Prerequisite: Chemistry 108, 122, 123, or equivalent; Physics 106, 107, and 108, or two semesters of general physics with concurrent registration in the third semester; credit or registration in Mathematics 140 or equivalent. STAFF.

344. **Physical Chemistry.** Continuation of Chemistry 342. 3/4 unit. Prerequisite: Chemistry 342. STAFF.

346. **Physical Chemistry of Macromolecules.** The physical properties of systems containing large molecules, with special emphasis on proteins, nucleic acids, and high polymers; the use of physical methods for the characterization of such substances. 3/4 unit. Prerequisite: Chemistry 344 or 340.

348. **Advanced Physical Chemistry.** The sequence Chemistry 348 and 349 is designed to give seniors and graduate students a unified treatment of physical chemistry on an advanced level. Topics discussed are the electronic structure and spectra of atoms, principles of wave mechanics, experimental and theoretical aspects of the chemical bond in diatomic and polyatomic molecules, statistical thermodynamics, and chemical kinetics. 1 unit. Prerequisite: Chemistry 344 or equivalent.

349. **Advanced Physical Chemistry.** Continuation of Chemistry 348. 1 unit. Prerequisite: Chemistry 348.

383. **Dynamics, Structure, and Physical Methods.** A laboratory course presenting the relationship of dynamics and structure with emphasis on the use of physical methods to follow the course of reactions. 1/2 unit. Prerequisite: Chemistry 136 and 181; credit or registration in Physics 108 and Mathematics 140.

385. **Chemical Fundamentals.** A laboratory course with experiments on the fundamental physical nature of chemical phenomena. 1 unit. Prerequisite: Registration in Chemistry 344; Chemistry 342 and 383.

392. **Applied X Rays.** Generation and detection of x rays, absorption and scattering of x rays by matter; crystals, crystal and molecular symmetry; techniques of x-ray diffraction; identification and analyses; deduction of atomic positions. 3/4 unit. Prerequisite: Chemistry 342 or consent of instructor.

394. **Applied X-Ray Laboratory.** Techniques of x-ray analysis; powder techniques; fluorescence analysis; Weissenberg, precession camera techniques; reduction of film data; determination of crystal structure. 1/4 to 1 unit. Prerequisite: Credit or registration in Chemistry 392, or consent of instructor.

395. **History of Science with Particular Reference to Chemistry.** 1/2 unit. Prerequisite: Twenty hours of laboratory science.

396. **Atomic Physics.** Same as Physics 381. A lecture and problem course presenting our modern knowledge of the nature and properties of electrons, light quanta, atoms and molecules. Topics discussed include evidence for the atomic nature of matter, the properties of free electrons and ions, photons and their interaction with matter, atomic

spectra and structure, molecular spectra and structure, and an introduction to the ideas of quantum mechanics. 1 unit. Prerequisite: General physics and Mathematics 343 or 345. It is recommended that chemistry majors take Chemistry 344 before registering in this course. A student may not receive credit for both Physics 381 (Chemistry 396) and Physics 386.

397. Radiochemistry. Same as Nuclear Engineering 397. Properties of radioactive nuclei, nature of radioactivity, nuclear structure, nuclear reactions, interactions of radiations with matter, chemical aspects of radioactivity work, and applications of nucleonics to chemistry. 3/4 unit. Prerequisite: One semester of physical chemistry or one semester of atomic physics or consent of instructor.

398. Radiochemistry Laboratory. Same as Nuclear Engineering 398. To accompany Chemistry 397. Radioactivity detection and tracer applications of radioisotopes in chemistry and other fields. Laboratory and discussions. 1/2 unit. Prerequisite: One semester of physical chemistry or one semester of atomic physics or consent of instructor.

Biochemistry

COURSES FOR GRADUATES

450. Chemistry of Biological Processes. A consideration at the molecular level of biological processes including bioenergetics, biosynthetic and degradative pathways of cellular components, metabolic regulation and enzyme reaction mechanisms. 1 unit. Prerequisite: Biochemistry 350 and 355.

452. Experimental Techniques in Biochemistry. Experiments on the isolation, purification, and analysis of biological material, including proteins and enzymes. Methods of studying constituents of biological material; their degradation products, and the metabolic processes, including the isolation and characterization of intermediates. 3/4 or 1 unit. Prerequisite: Biochemistry 350 and 355.

455. Biochemistry. Seminar. Discussions of current research and literature. Required of all graduate students whose major is biochemistry. 1/2 unit. Prerequisite: Biochemistry 350 and 355, or equivalent.

494. Chemical Basis of Biological Specificity. Same as Chemistry 494. Biological formation and interaction of large molecules; analysis of the structural features concerned with functional specificity in heteropolymers, viruses, and subcellular particles; nucleic acids and their role as genetic molecules; proteins in their role as genetic products with highly specific functions; metabolic interrelations of these molecules. 3/4 unit. Prerequisite: Chemistry 344 and 346, and Biochemistry 350 or 450; Microbiology 330; or consent of instructor.

499. Thesis Research. 0 to 4 units. Clark, Conrad, Foster, Dus, Gorski, Gunsalus, Hager, McClure, Schroepfer, Switzer, Weber, Wetmur, Wood.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

350. General Biochemistry. The chemistry and reactions of constituents of living matter, including carbohydrates, lipids, proteins, nucleic acids, vitamins, coenzymes, and minerals; the chemistry and regulation of the reactions and processes of whole organisms, plant and animal, of organs, cells, and subcellular particles and soluble components. Lectures and assigned readings. 3/4 unit. Prerequisite: Quantitative analytical chemistry and Chemistry 131 or 136, or equivalent.

351. Physicochemical Basis of Biochemistry. An introduction to the physicochemical methods and ideas underlying biochemistry. 3/4 unit. Prerequisite: Chemistry 340, or equivalent, or consent of instructor.

354. Introduction to Biochemistry. Lectures: Structure and function of living matter,

with emphasis on the mammalian organism. Laboratory: The isolation, chemical characterization, and function of the structural and catalytic components of living cells. This course is designed primarily to meet the needs of veterinary medicine, nutrition, dietetics, and other professional students. Open to other students only by special permission when space is available. This course does not meet the requirements for registration in advanced courses in biochemistry. 1 unit. Prerequisite: Quantative analytical chemistry and Chemistry 131 or 136, or equivalent; laboratory course in general biology, botany, or zoology; or consent of instructor.

355. **Biochemistry Laboratory.** To accompany Chemistry 350. An introduction to experimentation with biochemical systems, processes, and compounds of biochemical importance; identification and quantitative measurement of constituents and transformations in biological systems. Laboratory, quizzes, and assigned readings. Required of all students who expect to take advanced courses in biochemistry. 1 unit. Prerequisite: Quantitative analytical chemistry, Chemistry 131 or 136, or equivalent; registration in Biochemistry 350.

Chemical Engineering

COURSES FOR GRADUATES

464. **Transport Phenomena.** Analysis of the various phenomena associated with transport processes; mechanism and phenomenological description; equations of change; interphase transport. Application to systems involving the transfer of energy, mass, and momentum. 1 unit. Prerequisite: Mathematics 345 or 343; Chemical Engineering 373 or consent of instructor.

465. **Chemical Engineering.** Seminar. Required of all graduate students whose major is chemical engineering. $\frac{1}{4}$ unit. Prerequisite: Chemical Engineering 373.

466. **Applied Mathematics in Chemical Engineering.** The development of mathematical models and a survey of modern mathematical methods currently used in the solution of chemical engineering problems. Topics include the application of vectors and matrices, partial differential equations, numerical analysis, and methods of optimization in chemical engineering. $\frac{3}{4}$ or 1 unit. Prerequisite: Consent of instructor.

468. **Properties of Fluids.** The kinetic theory of gases and the prediction of transport coefficients; statistical mechanics applied to dense gases and liquids; theories of solutions. $\frac{3}{4}$ or 1 unit. Prerequisite: A background in modern physical chemistry and physics; consent of instructor.

469. **Special Topics in Chemical Engineering.** Various advanced topics are covered from time to time. These are generally taken during the second year of graduate study. Typical topics include turbulence, hydrodynamic instability, process dynamics, interfacial phenomena, reactor design, properties of matter at high pressure, phase transitions. This course may be repeated for credit. $\frac{3}{4}$ or 1 unit. Prerequisite: Chemical Engineering 464.

487. **Fluid Dynamics.** Basic concepts in fluid dynamics with special emphasis on topics of interest to chemical engineers. Derivation of the Navier-Stokes equations; solutions for creeping flow, for perfect fluids, and for boundary layers; non-Newtonian fluids; turbulence. 1 unit. Prerequisite: Chemical Engineering 464.

488. **Advanced Topics in Heat and Mass Transfer.** Principles of transfer operations developed in terms of physical rate processes. Boundary layer heat and mass transfer, eddy diffusion, phase changes, and separation processes. $\frac{3}{4}$ or 1 unit. Prerequisite: Chemical Engineering 464 or consent of instructor.

499. **Thesis Research.** Candidates for the master's degree who elect research are required to write a thesis. A thesis is always required for the Doctor of Philosophy. Not all candidates for thesis work necessarily are accepted. Any student whose major is in another

department must receive permission from the head of the Department of Chemistry ar Chemical Engineering to register in this course. 0 to 4 units. ALKIRE, DRICKAME ECKERT, HANRATTY, HUDSON, QUINN, SANI, SCHMITZ, WESTWATER.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

363. Introduction to Process Engineering. Same as Food Science 363. Fundamentals heat transfer, fluid flow, evaporation, drying, and other unit operations in the proce industries. For students in chemistry, engineering, and food science; not open to majo in chemical engineering. Lectures and problems. 3/4 unit. Prerequisite: Calculus consent of instructor.

367. Introduction to Process Control. An introduction to the control of industrial chem cal processes. Lecture and laboratory. 3/4 unit. Prerequisite: Mathematics 345 or 34 Chemical Engineering 371.

368. Selected Topics in Chemical Engineering. Study of selected topics in chemic engineering. The content of the course varies from semester to semester. Typical topi are optimization, chemical kinetics, phase equilibrium, biochemical engineering, kinet theory and transport properties, etc. 3/4 or 1 unit. May be repeated for credit. Pr requisite: Senior standing in chemical engineering or consent of instructor.

370. Chemical Engineering Thermodynamics. The fundamental concepts and laws thermodynamics. Primarily for students in chemical engineering. 1/2 unit. Prerequisit Chemical Engineering 261; Chemistry 342.

371. Principles of Chemical Engineering. Introduction to fluid dynamics and he transfer. Lectures, problems, and quizzes. 1 unit. Prerequisite: Chemical Engineerir 370 or consent of instructor.

373. Principles of Chemical Engineering. Introduction to mass transfer operation Lectures, problems, and quizzes. 1 unit. Prerequisite: Chemical Engineering 371.

374. Unit Operations Laboratory. To accompany Chemical Engineering 373. Laborato and computations in the unit operation. 1/2 unit. Prerequisite: Credit or registration i Chemical Engineering 373.

377. Process Dynamics. The basic ideas of process dynamics and their applications i chemical engineering. 3/4 unit. Prerequisite: Chemical Engineering 367 or consent instructor.

379. Chemical Engineering Projects. Laboratory. Development of an individual projec 1/2 unit. Prerequisite: Senior standing in chemistry or chemical engineering.

380. Heat, Mass, and Momentum Transport. A unifying treatment of physical rat processes with particular emphasis on the formulation and solution of typical boundar value problems associated with heat, mass, and momentum transport. 3/4 unit. Pre requisite: Mathematics 343 or 345; Chemical Engineering 371; or consent of instructo

381. Chemical Reactor Design. Chemical kinetics and chemical reactor design with con sideration of the interrelationship between the reactor and heat and mass transfe equipment used in a chemical conversion. 3/4 unit. Prerequisite: Chemical Engineerin 373.

382. The Prediction of Physical Properties. The prediction of equilibrium and transpo properties in gases, liquids, and solids. 1/2 unit. Prerequisite: One year of physica chemistry.

CIVIL ENGINEERING

(Including Sanitary Engineering)

The Department of Civil Engineering offers a combination of advanced study and pa ticipation in creative research to meet the needs of individual students. Such graduate trainin prepares students to assume greater responsibilities and to contribute to the progress of th civil engineering profession. Graduate study and research can be pursued in the fields of a pollution; analysis and design of structures; behavior of structures and properties of structura materials; materials science; construction engineering and management; digital compute

applications to analysis or design; engineering stochastics and systems reliability; geodetic engineering; highway engineering; hydrology; hydromechanics and hydraulic structures; materials and structural design of roadways; models research; nuclear structural shielding; photogrammetry and photogrammetric engineering; radiological health; railway engineering; rock mechanics; soil mechanics and foundations; solid wastes management; stream analysis; structural dynamics; design for earthquake, shock, and blast excitation; structural mechanics; systems analysis and design and operations; traffic engineering; transportation planning; urban planning and management; waste water treatment; water quality and treatment; and water resources.

The Master of Science and Doctor of Philosophy in Civil Engineering and in Sanitary Engineering may be attained by qualified students who satisfy the requirements of the department and the Graduate College. Progress toward an advanced degree is measured by the accumulation of units of credit in formal course work and by evidence of intellectual growth and achievement. The prerequisite for graduate work is the equivalent of the undergraduate courses required for the Bachelor of Science in Civil Engineering, or in one of the physical or life sciences, or other degree work which meets with the approval of the department.

Admission to the Graduate College with full status in civil or sanitary engineering is granted to graduates of institutions whose requirements for the bachelor's degree are substantially equivalent to those of the University of Illinois, provided the applicant's preparation is appropriate to advanced study in his chosen major field and his scholastic average is at least 4.0. Under certain conditions, applicants with a grade-point average of less than 4.0, and applicants from schools with different grading systems, may be considered if their average is equivalent to or higher than 3.75 and evidence is submitted indicating that the applicant's ability is not appropriately measured by the grades submitted.

Because of the wide range of interests in graduate work in the Department of Civil Engineering, there are no specific course prerequisites for a major in the department. The requirements for a major or minor must be approved by the head of the department. A minimum of eight units must be completed for the master's degree when a thesis is included. If a thesis is not included, nine units are required.

The department is presently engaged in a substantial building program which will reach completion in several phases. The new laboratories have extensive facilities for the study of the fundamental behavior of structures and structural materials, for the study of various environmental conditions found in the sanitary engineering and sanitary sciences, for the study of hydrosystems, and for the study of computer systems.

A pamphlet entitled *Graduate Study and Research in Civil and Sanitary Engineering* is available upon request to the head of the Department of Civil Engineering.

FACULTY

Professors: N. M. Newmark (Head of Department), W. C. Ackermann, A. H-S. Ang, J. E. Baerwald, J. W. Briscoe, A. B. Chilton, V. T. Chow, E. Danner, D. U. Deere, D. C. Drucker (Dean of College of Engineering), R. S. Englebrecht, R. A. Eubanks, B. B. Ewing, S. J. Fenves, E. H. Gaylord, W. J. Hall, J. D. Haltiwanger (Associate Head of Department), W. W. Hay, M. Herrin, H. K. Hilsdorf, H. O. Ireland, H. M. Karara, C. E. Kesler, N. Khachaturian, R. W. Larimore, T. E. Larson, W. H. Munse, J. P. Murtha, R. E. Olson, J. E. Pearson, R. B. Peck, J. T. Pfeffer, A. R. Robinson, M. O. Schmidt, W. C. Schnobrich, L. R. Shaffer, C. P. Siess, G. K. Sinnamon, M. A. Sozen, J. E. Stallmeyer, T. H. Thornburn, R. W. Woodhead.

Associate Professors: E. J. Barenberg, M. T. Davisson, R. I. Dick, W. L. Gamble, G. R. Gurfinkel, A. J. Hendron, Jr., E. R. Holley, Jr., V. J. McDonald, J. W. Melin, R. J. Mosborg, N. N. Nielsen, J. T. O'Connor, M. R. Thompson, W. H. Walker, R. N. Wright.

Assistant Professors: M. Ali-Akbarian, M. Amin, P. C. Birkemoe, G. S. Birrell, L. T. Boyer, A. G. R. Bullen, E. J. Cording, B. J. Dempsey, J. L. Eades, S. M. Holzer, F. V. Lawrence, Jr., H. V. Leland, L. A. Lopez, C. R. Marek, W. H. C. Maxwell, D. D. Meredith, B. Mohraz, S. L. Paul, J. B. Radziminski, Q. L. Robnett, V. L. Snoeyink, W. Tang, J. R. Weggel, Jr., H. G. Wenzel, Jr., K. W. Wong, B. C. Yen.

COURSES FOR GRADUATES

403. Analogue Photogrammetry, I. Study of the fundamental concepts of the analogu approach in photogrammetry; characteristics, capabilities, and limitations of analogu photogrammetric data reduction systems; theory of errors of interior and exterior orier tation, methods of relative and absolute orientation; model deformations; critic surfaces. 1 unit. Prerequisite: Civil Engineering 203 or consent of instructor.

404. Analogue Photogrammetry, II. Two- and three-dimensional aerotriangulatior auxiliary data; propagation of errors; strip and block adjustment; design criteria fo aerotriangulation projects. 1 unit. Prerequisite: Civil Engineering 403 or consent c instructor.

405. Analytical Aerotriangulation. Iterative and simultaneous rigorous block adjust ment methods, numerical methods for the solution of large systems of equations; char acteristics of various analytical photogrammetric systems. 1 unit. Prerequisite: Civi Engineering 304 or consent of instructor.

416. Design of Construction and Industrial Operations, I. Same as Industrial Engineer ing 416. Conceptual development of a systems design procedure for optimal design of con struction and industrial operations; general forms required for critical path networks linear programs, theory of queues and inventory models required for systems design design evaluation and control models. 1 unit. Prerequisite: Bachelor of Science in civi or industrial engineering, credit, or registration in Mathematics 363, or consent of in structor.

417. Design of Construction and Industrial Operations, II. Same as Industrial Engi neering 417. Continuation of Civil Engineering 416. 1 unit. Prerequisite: Civil Engi neering or Industrial Engineering 416; credit or registration in Mathematics 315; or consent of instructor.

420. Pavement Design, I. Analysis and methods of measurement of surface properties related to vehicle performance; factors affecting pavement durability; traffic wear, climate, chemical action, combined effects; composition design of flexible and rigid pavements for proper surface properties, load carrying capacity, wear resistance, stability, and durability. 1 unit. Prerequisite: Civil Engineering 220 or equivalent.

421. Pavement Design, II. Structural design of flexible and rigid pavements; loading characteristics, static, impact and repeated loads; load distribution through pavement layers, factors affecting distribution, methods of analysis; evaluation of subgrade support; criteria for selecting design values. 1 unit. Prerequisite: Civil Engineering 220 or equivalent.

422. Fundamental Properties and Behavior of Bituminous Mixtures. Composition and theories of physical structure of bitumens; rheological, failure, durability, and adhesive properties of bitumens and bituminous mixtures; analysis of factors influencing the performance of bituminous aggregate mixtures. 1 unit. Prerequisite: Civil Engineering 321 or consent of instructor.

423. Highway Materials Stabilization. Stabilization of aggregates and soils with cement, lime, bituminous materials, and other stabilizing agents; basic stabilization reactions, properties of stabilized materials, and composition design are emphasized. 1 unit. Prerequisite: Civil Engineering 220 or consent of instructor.

426. Traffic Planning. Traffic engineering planning functions; urban and rural master traffic plans; traffic analyses for new or existing streets, highways, and terminal facilities. 1 unit. Prerequisite: Civil Engineering 325 or equivalent.

427. Geometric Highway Design. Highway classification; highway capacity; highway design controls; sight distance; horizontal and vertical alignment; cross section elements; highway types; controlled access highways; design of at-grade of intersections, grade separations, and interchanges. 1 unit. Prerequisite: Civil Engineering 325 and 426, or consent of instructor.

428. Traffic Engineering Operations. Theory of traffic control; laws and ordinances; design and application of traffic control devices; special street designations; parking design and control; street illumination; miscellaneous traffic control designs. 1 unit. Prerequisite: Civil Engineering 325 and 426, or equivalent.

435. Railway Construction and Maintenance. Roadbed load capacity; economic design of track; advanced geometric design; economics of maintenance; grade crossing separations; review of specific projects. 1 unit. Prerequisite: Civil Engineering 335.

436. Railroad Location and Operation. Track and traffic capacity; optimum train size, performance, and scheduling; validity and accuracy of current practices; regional operating factors; optimum size of plant and modern location. 1 unit. Prerequisite: Civil Engineering 336 or consent of instructor.

440. Theory of Water Treatment. Properties of water and criteria of water quality; gas transfer operations in water treatment; chemical treatment processes; corrosion and corrosion control; sedimentation; filtration; disinfection; control of aquatic growths; control of tastes and odors. 1 unit. Prerequisite: Chemistry 122; Microbiology 101.

441. Analysis and Treatment of Water and Waste Water. Physical, biological, and chemical analysis of water and waste water; field sampling techniques; removal of objectional impurities, principles of disinfection; determination of dissolved oxygen, biochemical oxygen demand, and chemical oxygen demand; nitrogen, sulfur, and phosphorous compounds in waste waters. 1 unit. Prerequisite: Credit or registration in Civil Engineering 440.

442. Theory of Waste-Water Treatment. Composition, properties, and analysis of wastes; microbiology of waste treatment; pollution of natural waters; sedimentation; chemical treatment; aerobic and anaerobic treatment processes; disposal of waste sludges. 1 unit. Prerequisite: Civil Engineering 346; Chemistry 122; Microbiology 101.

443. Advanced Sanitary Engineering Laboratory. Experimental and pilot plant studies of the operational characteristics for various physical, chemical, and biological unit operations and processes used in the treatment of water and waste water. 1 unit. Prerequisite: Civil Engineering 441; credit or registration in Civil Engineering 442.

444. Industrial Water and Wastes Treatment. The theory and application of unit operations unique to the treatment of industrial water and wastes; advanced consideration of industrial waste problems of major industries; techniques of saline water conversions. 1 unit. Prerequisite: Credit or registration in Civil Engineering 440 and 442, or consent of instructor.

445. Water Quality and Pollution. Water quality standards and criteria for various beneficial uses; transport mechanisms for pollution in surface streams and ground water; fate of pollution and pollution control. 1 unit. Prerequisite: Civil Engineering 250 and 251; Mathematics 345.

446. Design of Water and Waste Treatment Plants. A study of the fundamental factors affecting choice of treatment units and combination of unit processes into an integrated plant. 1 unit. Prerequisite: Civil Engineering 440, credit or registration in Civil Engineering 442, or consent of instructor.

447. Radioactive Waste Disposal. Same as Nuclear Engineering 447. Sources and characteristics of radioactive wastes; methods of treatment; ultimate disposal; fate of radioisotopes in the environment; permissible levels in air and water; current levels in water supplies; water treatment methods; monitoring techniques; solid waste disposal; gaseous wastes disposal; air-monitoring; and reactor site selection and hazards evaluation. $\frac{1}{2}$ or 1 unit. Prerequisite: Physics 282, or Chemistry or Nuclear Engineering 398, or consent of instructor.

448. Control of Air Pollution. A study of air contaminants from all types of sources; deleterious effects of contaminants on plants, animals, and materials; determination of source strength; basic theory of control devices; air pollution surveys; and organization of control programs. 1 unit. Prerequisite: General Engineering 360.

449. Analysis of Air Pollutants. Laboratory analysis of common air pollutants; theory of operation of laboratory and automatic field instrumentation. ½ to 1 unit. Prerequisite: Credit or registration in Civil Engineering 448.

450. Advanced Hydrologic Analysis and Design. Hydrologic cycle; hydrometeorology; collection of data; hyetograph and hydrograph analyses; infiltration and evapotranspiration studies; ground water exploration and recharge; statistical analyses; determination of waterway areas; flood routing; river and reservoir regulations; design and planning of flood control projects; and modern development such as radar weather, radioactive tracers, disposal of nuclear wastes, and electronic analogs. 1 unit. Prerequisite: Bachelor of Science in civil engineering or consent of instructor.

452. Water Resources. An advanced interdisciplinary course on water resources planning and development; geographic aspects; data collection; governmental functions; hydrologic implications; river hydraulics; hydraulic physical units and water quality; economic aspects; legal, political, and social problems; case studies. 1 unit. Prerequisite: Consent of instructor.

457. Ground Water. An advanced interdisciplinary course on ground water; hydrogeology; hydrodynamics of flow through porous media; ground water hydrology; hydraulics of wells; hydraulic analysis of seepage; ground water pollution; ground water resources. 1 unit. Prerequisite: Consent of instructor.

458. Open-Channel Hydraulics. Basic hydromechanics; flow types; channel characteristics; flow-profile computations; hydraulic jump analysis; design of nonerodible, erodible, and grassed channels and transitional structures; study of supercritical flow and unsteady flow; modern developments in theory and design practice; application of numerical method, method of characteristics, method of singular point, and electronic digital computers and analogs. 1 unit. Prerequisite: Bachelor of Science in civil engineering or consent of instructor.

461. Matrix Formulation of Structural Analysis. Development of structural analysis algorithms in matrix formulation: force and displacement vectors and transformations, element property matrices, representation of structures as assemblages of elements, displacement and force methods of analysis, selected advanced topics. 1 unit. Prerequisite: Civil Engineering 361 or equivalent.

463. Optimization of Structures. Structural design processes; formulation of problems in the optimization of structures; optimization of structural elements; minimum volume principles; use of mathematical programming in optimization of structural systems. 1 unit. Prerequisite: Consent of instructor.

465. Structural Design in Metals. Theories of behavior of structural metal members and their components; interpretation of codes and specifications for the design of bridges and buildings. This course and Civil Engineering 475 form a unit in the study of theoretical and experimental investigations. 1 unit. Prerequisite: Bachelor of Science in engineering with courses in structures.

467. Behavior of Reinforced Concrete Structures. Ultimate strength and behavior of statically indeterminate reinforced concrete structures; applicability of elastic analysis to framed structures; analysis and design of floor slabs in buildings. 1 unit. Prerequisite: Civil Engineering 366.

469. Thin Shell Structures. Fundamental membrane and bending theories of shells; application of theories to analysis and design of folded plates and cylindrical, rotational, and translational shells; membrane stresses and deflections; and approximate bending solutions by variational, finite-difference, and finite-element methods. 1 unit. Prerequisite: Civil Engineering 473 or consent of instructor.

470. Structural Safety and Reliability. Development of concepts and methods of probabilistic structural mechanics relevant to the analysis of structural safety and reliability. Concepts of probability and stochastic processes; statistical consideration of loads and structural resistances; engineering significance of statistical extremes; factor of safety

and failure probability; prediction of system reliability; design for safety against natural destructive forces including wind and earthquakes. 1 unit. Prerequisite: Consent of instructor.

471. Numerical and Approximate Methods of Structural Analysis. Methods of successive approximations and numerical procedures for the solution of complex problems with applications to bridges, buildings, and aircraft structures: influence lines, moments and deflections of beams with axial load, buckling strength of columns, moments and deflections of beams resting on elastic or plastic supports, vibration of beams, analysis of arches, moments, and deflections of plates; other problems. 1 to 2 units.

472. Advanced Numerical Methods in Engineering. Basic concepts in numerical and approximate methods: successive approximations, relaxation, finite differences, ordinary boundary value problems, initial value problems, partial differential equations, characteristic value problems, methods of interpolation, variational procedures. Special study of selected topics including vibrations of complex structures; blast, impact, and earthquake effects on structures; buckling and flexure of frameworks; torsion of solid and thin-walled sections; lateral buckling of beams; bending and buckling of plates and of stiffened plates; plane stress and axially symmetric problems in elasticity; other topics. 1 to 2 units. Prerequisite: Civil Engineering 471.

473. Analysis and Design of Plates and Shells. Fundamental theories of bending and buckling of plates; practical application of theories in analysis and design of reinforced concrete bridge and building floors, highways and airport pavements, and structural plate components in metal; theory of shells with application to tanks, pressure vessels, shell roofs, and hipped plate constructure. 1 to 2 units. Prerequisite: Consent of instructor.

474. Dynamics of Framed Structures. Advanced treatment of the dynamics of multi-degree of freedom framed structural systems; fundamental concepts of eigenvalue theory of real matrices and energy principles of dynamics as bases for a unified approach to dynamical problems of structural assemblages; structural idealizations, principles of dynamics, Lagrange's equations, response calculations, normal mode method and its limitations, transfer matrix approach, computer utilization. 1 unit. Prerequisite: Civil Engineering 361, 374, or equivalent.

475. Behavior of Steel Structures. A critical evaluation of the actual behavior of metals, connections, members, and structures; the significance of this behavior in terms of design and the development of design specifications. This course and Civil Engineering 465 form a unit in the study of theoretical and experimental investigations. 1 unit. Prerequisite: Graduate standing in civil engineering or theoretical and applied mechanics.

476. Plastic Analysis and Design. Inelastic behavior of metal structural frameworks; concept of the plastic hinge; collapse configurations; analysis of collapse mechanisms; requirements for stability; deflections, incremental collapse, shakedown; connections; optimum design; grid frameworks. 1 unit. Prerequisite: Civil Engineering 465 or consent of instructor.

477. Design of Structures for Dynamic Loads. Nature of dynamic loading from earthquakes and bomb blasts; nature of dynamic resistance of structural elements and complete structures; concepts of limit design; review of methods of analysis; significance and interpretation of results of analyses; criteria for design of blast-resistant structure; criteria for design of earthquake-resistant structures; application to actual problems. 1 unit. Prerequisite: Civil Engineering 374 or consent of instructor.

478. Discrete Methods of Solid and Structural Mechanics. Concepts and methods for the discrete formulation and solution of structural and solid mechanics problems. Discrete idealization of solid media and structures by lumped-parameter and finite element approaches; stress analysis and wave propagation in plane and axi-symmetric solids; analyses of plate and shell structures; inelasticity and non-linearity; special boundary conditions; special problems, including soil and rock mechanics problems, and structure-medium interaction. 1 unit. Prerequisite: Civil Engineering 379, Aeronautical and Astronautical Engineering 326 or Theoretical and Applied Mechanics 351

or equivalent, and registration in Computer Science 400 or equivalent; or consent of instructor.

480. Earth Pressures and Retaining Structures. Classical and modern earth pressure theories and their experimental justification; pressures and bases for design of retaining walls, bracing of open cuts, anchored bulkheads, cofferdams, tunnels, and culverts. 1 unit. Prerequisite: Credit or registration in Civil Engineering 384.

481. Earth Dams and Related Problems. Fundamentals of problems of slope stability; seepage in composite sections and anisotropic materials; methods of stability analysis; mechanism of failure of natural and artificial slopes; compaction; field observations. 1 unit. Prerequisite: Credit or registration in Civil Engineering 384, or consent of instructor.

482. Advanced Soil Mechanics, I. Theoretical and experimental studies in soil mechanics, stress distribution in homogeneous and stratified soils, theory of consolidation for multidirectional flow and time dependent loading, numerical methods, secondary consolidation, settlement analysis, experimental measurements. 1 unit. Prerequisite: Civil Engineering 383.

483. Advanced Soil Mechanics, II. Theoretical and experimental studies in soil mechanics, shearing properties of saturated soils, physical properties of partially saturated soils, physicochemical properties of clays, laboratory direct shear and triaxial shear testing. 1 unit. Prerequisite: Civil Engineering 383.

484. Foundation Engineering. Critical study of case histories of projects in foundation engineering; current procedure for design and construction of foundations, embankments, and waterfront structures. 1 unit. Prerequisite: Civil Engineering 384.

485. Soil Engineering for Transportation Facilities. Problems of soil classification; evaluation of stability of natural and compacted soils as subgrades, slopes, and embankments; effect of climate, soil properties, compaction, and admixtures on subgrade stability. 1 unit. Prerequisite: Civil Engineering 383 or equivalent.

494. Municipal Administration and Engineering. Legal authority of municipalities, forms of municipal government; municipal functions, organization, and management; city finance; engineering functions of city government; city planning and zoning; building codes and inspection; street lighting; public utilities; city cleaning; recreational development. 1 unit. Prerequisite: Bachelor of Science in civil engineering or consent of instructor.

495. Civil and Sanitary Engineering Seminar. Discussion of current topics in civil and sanitary engineering and related fields by staff, students, and visiting lecturers. Course may be repeated. 0 or $\frac{1}{4}$ unit.

497. Special Problems. Individual investigations or studies of any phase of civil engineering selected by the student and approved by his adviser and the staff member who will supervise the investigation. 0 to 4 units. Prerequisite: Consent of instructor.

499. Thesis Research. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

304. Fundamentals of Analytical Photogrammetry. An introduction to the basic principles, procedures, and methods of analytical photogrammetry, including relative and absolute orientation, and strip and block adjustment. $\frac{3}{4}$ or 1 unit. Prerequisite: Civil Engineering 203 and 306, or consent of instructor.

305. Observational Astronomy. Same as Astronomy 314. Astronomical coordinate systems and transformations; theory of, and practice in, approximate and precise determinations of latitude, longitude, and time; introduction to theory of errors; theory and practice of astronomical photography. 1 unit. Prerequisite: Astronomy 102 or 210, or Civil Engineering 201; Mathematics 142 or 143.

306. Adjustment of Observations. A study of the methods of least squares and its applica

tion to the adjustment of photogrammetric and geodetic problems; formation and solution of the normal equations, including the use of matrix algebra; types of adjustments including adjustments for hybrid systems; discussion of the normal distribution and the statistical foundations of the method of least squares. $^{5}/_{4}$ or 1 unit. Prerequisite: Mathematics 315 and Civil Engineering 202, or consent of instructor.

307. Photogrammetric Engineering. A study of metrical photography in civil engineering practice, analytical and analogue photogrammetric systems, photometrics and outer space mapping techniques, and automated photographic mapping systems. $^{3}/_{4}$ or 1 unit. Prerequisite: Civil Engineering 203 or consent of instructor.

309. Geodetic Engineering. Geodetic positioning on a reference ellipsoid, least squares adjustment of first-order triangulation and trilateration nets using observation equations, satellite triangulation, principles and operations of modern instruments, geodetic levelling, map projections, rational design of geodetic systems. $^{3}/_{4}$ to 1 unit. Prerequisite: Civil Engineering 201 or consent of instructor.

314. Fundamentals of Systems Approach. Introduction to the application of linear programming, network theory, and queueing theory to the synthesis of civil engineering systems. $^{1}/_{2}$ or 1 unit. Prerequisite: Civil Engineering 215; Mathematics 263 or consent of instructor.

315. Construction Productivity. Introduction to the application of scientific principles to the measurement of, and the forecasting of, productivity in construction engineering; conceptual and mathematical formulations of the labor, equipment, and material factors affecting productivity. $^{1}/_{2}$ or 1 unit. Prerequisite: Civil Engineering 215; credit or registration in Mathematics 263 or equivalent; or consent of instructor.

316. Construction Planning. Introduction to the application of scientific principles to the normative planning of construction operations. $^{1}/_{2}$ or 1 unit. Prerequisite: Civil Engineering 315 or consent of instructor.

318. Construction Cost Analyses and Estimates. Introduction to the application of scientific principles to costs and estimates of costs in construction engineering; concepts of and statistical measurements of the factors involved in direct costs, general overhead costs, cost mark-ups and profits; the fundamentals of cost recording for construction cost accounts and cost controls. $^{1}/_{2}$ or 1 unit. Prerequisite: Civil Engineering 315 or consent of instructor.

321. Bituminous Materials and Mix Design. Properties and control testing of bituminous materials; analysis of bituminous paving mixtures; composition and design of asphaltic concrete and soil-asphalt mixes. $^{1}/_{2}$ unit. Prerequisite: Civil Engineering 214 and 220, or consent of instructor.

322. Development of Highway Facilities. Analysis of factors in developing a highway transportation facility; traffic estimates and assignment; problems of highway geometrics and design standards; planning and location principles; intersection design factors; street systems and terminal facilities; programming improvements; drainage design; structural design of surface; concepts of highway management and finance; highway maintenance planning. 1 unit. Prerequisite: Civil Engineering 220 or consent of instructor.

325. Highway Traffic Characteristics. Vehicle operating characteristics; driver characteristics; pedestrian characteristics; roadway characteristics, individually and collectively as traffic stream characteristics, are related to the planning, design, and operation of highway facilities. $^{1}/_{2}$ unit. Prerequisite: Civil Engineering 220 or consent of instructor.

333. Urban and Regional Transportation. Importance of transportation and its relation to urban and regional planning; characteristics of transport systems; transportation planning including surveys, data analysis, and problems of administration and finance; coordination and integration of transport. $^{1}/_{2}$ or 1 unit. Prerequisite: Consent of instructor.

334. Airport Design. Basic principles of site selection for airports and fundamental considerations of design, construction, and maintenance of airport pavements and structures. $\frac{1}{2}$ or 1 unit. Prerequisite: Civil Engineering 220 and senior standing in civil engineering, or consent of instructor.

335. Railway Construction and Maintenance. Loads and load distribution on track and subgrade; roadbed construction and stabilization; track stresses, design, and materials; turnouts and crossings; maintenance programs. $\frac{1}{2}$ or 1 unit. Prerequisite: Consent of instructor; credit or registration in Civil Engineering 230 for those with a minor in railroad or transportation engineering.

336. Railway Location and Operation. Influence of traffic, alignment, distance, gradients, and motive power upon operating expenses; mechanics of train operation; economic design of location. $\frac{1}{2}$ or 1 unit. Prerequisite: Consent of instructor; credit or registration in Civil Engineering 230 for those with a minor in railroad or transportation engineering.

337. Signals. Train movements; systems of signals; track circuits; track capacity; interlockings; economics of signaling. $\frac{1}{2}$ or 1 unit. Prerequisite: Consent of instructor; credit or registration in Civil Engineering 230 for those with a minor in railroad or transportation engineering.

338. Terminals. Design and operation of freight terminal facilities for rail, highway, air, and water carriers; passenger terminals; special terminal requirements for specific commodity categories; coordination. $\frac{1}{2}$ or 1 unit. Prerequisite: Consent of instructor; credit or registration in Civil Engineering 230 for those with a minor in railroad or transportation engineering.

345. Environmental Health Engineering. The application of engineering principles to the control of environmental sanitation and communicable disease control, including administration, biostatistics, epidemiology, vector control, pesticides, milk and food sanitation, swimming pools, individual water supply and wastewater disposal, plumbing, refuse collection and disposal, industrial hygiene and air pollution, radiological health and international health. $\frac{3}{4}$ unit. Prerequisite: Consent of instructor.

346. Biology of Polluted Water. The significance of biology in water quality, stream pollution, and waste treatment. $\frac{1}{2}$ unit. Prerequisite: Consent of instructor.

349. Fundamentals of Radiation Protection. Same as Nuclear Engineering 349. Principles and practice of health physics and radiation protection engineering, including such topics as: principles of dosimetry; sources of ionizing radiation; determination of radiation tolerances; dosimetric instruments; standards and regulations. $\frac{3}{4}$ or 1 unit. Prerequisite: Credit or registration in Nuclear Engineering 397 or Physics 382, or equivalent.

351. Hydromechanics. Applied fluid mechanics with particular reference to topics in hydraulic design, analysis, and research in civil engineering areas; covers dimensional analysis and dynamic similarity, analysis of potential flow, boundary-layer problems, turbulence, and diffusion; hydraulic transients, water waves, transport phenomena. $\frac{3}{4}$ unit. Prerequisite: Theoretical and Applied Mechanics 235; Civil Engineering 251.

352. Water Resources Design. Study and evaluation of phases of river mechanics; water resources history and project implementation; development of a water resources project plan. $\frac{3}{4}$ unit. Prerequisite: Civil Engineering 250; Theoretical and Applied Mechanics 235.

353. Hydraulic Structures. Introduction to the design of hydraulic structures, including consideration of types and function of dams; hydrologic design; hydraulic design of spillways and outlet works; determination of loads and stresses for concrete structures; seepage, piping, and stability of earth structures. $\frac{3}{4}$ unit. Prerequisite: Civil Engineering 250 and 251.

356. Hydraulics of Surface Drainage. Application of hydraulic and hydrologic principles; elements of channel design, hydrologic determination of design flow; flow through

bridge openings and other obstacles; hydraulics of drainage areas; overland flow; runoff from highways; runways and urbanized areas; hydraulics of storm-drain systems; culvert design. ¾ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 235; Civil Engineering 250 or consent of instructor.

361. **Advanced Structural Analysis.** A unified development of force and displacement analysis methods for linearly elastic framed structures including introduction to matrix methods of formulation; applications to plane and space frames and trusses; computer use. ¾ or 1 unit. Prerequisite: Civil Engineering 262 or equivalent.

363. **Behavior and Design of Metal Structures, II.** Members under combined loads; welded, riveted, and bolted connections; moment-resistance connections; plastic design. ¾ or 1 unit. Prerequisite: Civil Engineering 263 or consent of instructor.

364. **Reinforced Concrete Design, II.** Limit design of continuous reinforced concrete members and slabs of various types. ¾ or 1 unit. Prerequisite: Civil Engineering 264; credit or registration in Civil Engineering 262.

366. **Behavior of Reinforced Concrete Members.** Ultimate strength and behavior of reinforced concrete members and relation between results of research and current specifications for design; members subjected to flexure, axial compression, combined flexure and axial load, combined flexure and shear, and bond. 1 unit. Prerequisite: Bachelor of Science in civil engineering or architecture with courses in structures and reinforced concrete design.

368. **Prestressed Concrete.** Principles and methods of linear prestressing; behavior, strength, and design of noncomposite simple beams, composite simple beams, and continuous beams; time-dependent variables and long-time deflections. ¾ or 1 unit. Prerequisite: Civil Engineering 262 and 264.

369. **Behavior and Design of Wood Structures.** Theory and practice in design of modern wood structures; effect of plant origin and physical structure of wood on its mechanical strength; fasteners and their significance in design and the development of design formulae. ¾ or 1 unit. Prerequisite: Civil Engineering 261 or equivalent, or consent of instructor.

374. **Introduction to Structural Dynamics.** Analysis of the dynamic response of structures and structural components to transient loads and foundation excitation; single-degree-of-freedom and multidegree-of-freedom systems; response spectrum concepts; simple inelastic structural systems; introduction to systems with distributed mass and flexibility. Credit is not given for both Civil Engineering 374 and Theoretical and Applied Mechanics 311. ¾ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 212; Mathematics 345; Civil Engineering 261; or equivalent.

379. **Applied Structural Mechanics.** Study of beams under lateral load; beams with combined lateral load and thrust; buckling; beams on elastic foundations; applications of Fourier series and virtual work principles to beam-type structures; stress and strain in three dimensions; applications to flexure of beams and plates and to constrained torsion; elements of the engineering theory of plates. ¾ or 1 unit. Prerequisite: Mathematics 345 and one undergraduate course in statically indeterminate structures, or consent of instructor.

383. **Soil Mechanics.** Identification, description, and classification of soils; index properties, weight-volume relationships; hydraulic properties; stress-deformation characteristics; ultimate strength; subsurface exploration; character of natural soil deposits. ¾ or 1 unit. Prerequisite: Consent of instructor.

384. **Applied Soil Mechanics.** Application of soil mechanics to foundations of buildings; stability of earth slopes; earth pressure and retaining walls; braced cuts; damage due to construction operations. ¾ or 1 unit. Prerequisite: Civil Engineering 383 or consent of instructor.

385. **Engineering Aspects of Surficial Soils.** Use of geologic and pedologic information and airphoto interpretation techniques in the prediction of engineering properties of

soils and the planning of engineering soil surveys. Field trip; estimated expense, $5.00. 1 unit. Prerequisite: Civil Engineering 210 or consent of instructor.

391. Computer Methods in Civil Engineering. Review of programming concepts; formulation and programming of numerical, data-processing, and logical problems with applications to various branches of civil engineering; organization of programs and data; development and use of problem-oriented programming languages in civil engineering. ½ or 1 unit. Additional work required for more than ½ unit of credit. Prerequisite: Computer Science 101 or equivalent; senior or graduate standing in the Department of Civil Engineering or consent of instructor.

THE CLASSICS

(Including Classical Civilization, Greek, and Latin)

The Department of Classics offers graduate work leading to the Master of Arts and Doctor of Philosophy.

The Master of Arts may be taken in Latin, in Greek, in the Classics, or in the Teaching of Latin. For the Master of Arts in the Classics, the major may be either Latin or Greek, with the other language offered as a minor. No master's thesis is required; extra units of work in Greek or Latin are substituted for the thesis.

The Doctor of Philosophy is given in Classical Philology. Major work may be taken in either Latin or Greek, but whichever language is taken as a major, the other one must be taken either as the sole minor or as a first minor.

The minimum grade-point average for admission to graduate study in the department is 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis. All graduate students should take Greek or Latin 495-496 Bibliography and Criticism, during their first year of graduate study. Other regulations of the department governing graduate studies are described in a departmental brochure which may be obtained by writing to the Head of the Department, 361 Lincoln Hall.

FACULTY

Professors: J. J. Bateman (Head of Department), J. L. Heller, R. P. Oliver, L Wallach.
Associate Professors: M. Naoumides, R. T. Scanlan.
Assistant Professors: H. A. Allen, H. Jacobson, H. Marblestone, V. K. Robbins.

Classical Civilization

The following courses presuppose no knowledge of the Greek or Latin language and are open to all students. For other courses in the area of classical civilization, see Art 304, 305, 306, 307, and 454; History 381, 382, 383, 384, 411, and 413; Philosophy 303, 309, 310, and 401; and Speech 411 and 412.

COURSES FOR GRADUATES

445. Field Work in Classical Archaeology. Participation in archaeological excavation; methods and procedures are discussed and practiced in actual working conditions. 1 unit. Prerequisite: Consent of instructor.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Greek Literature in Translation. An introduction to Greek literature from Homer to the Hellenistic age and to its cultural and historical background. ½ unit. Prerequisite: Consent of instructor.

302. Latin Literature in Translation. An introduction to Latin literature of the classic

period and to its cultural and historical background. ½ unit. Prerequisite: Consent of instructor.

361. **The Archaeology of Greece.** Monuments and material remains illustrating the development of Greek civilization to 323 B.C. ½ unit. Prerequisite: A course in ancient history, art, or language, or consent of instructor. ALLEN.

362. **The Archaeology of Italy.** Monuments and material remains illustrating the development of Graeco-Roman and other ancient Italian civilizations to 303 A.D. ½ unit. Prerequisite: A course in ancient history, art, or language, or consent of instructor. ALLEN.

Greek

Preparation for first-year graduate work in Greek should include at least three years of college Greek, or equivalent, and two years of college Latin. A reading knowledge of German and French is important for candidates in this subject. The study of history and philosophy is especially recommended.

COURSES FOR GRADUATES

In any given semester, a selection from the following courses is offered. Consult the departmental office, 361 Lincoln Hall, well in advance of registration.

Unless otherwise noted, the prerequisite to all courses is three years of college Greek.

409. **Greek Versification.** Greek prosody; survey of meters, lines, and cola in epic, lyric, and dramatic poetry; lyric meters of Greek drama. 1 unit.

411. **Hellenistic Literature.** 1 unit.

412. **Lucian and His Age.** 1 unit.

413. **Greek Lyric Poetry.** 1 unit. NAOUMIDES.

414. **Pindar.** 1 unit. NAOUMIDES.

415. **Homer.** 1 unit.

416. **Thucydides.** 1 unit. NAOUMIDES.

417. **Bacchylides.** 1 unit. NAOUMIDES.

420. **Plato.** 1 unit. Prerequisite: Greek 391 or equivalent.

422. **Sophocles.** 1 unit.

423. **Aeschylus.** 1 unit.

424. **Euripides.** 1 unit.

425. **Greek Drama: Comedy.** 1 unit.

460. **Studies in Patristic Greek Literature.** Aspects of the religious and social history of early Christianity on the basis of Greek Patristic texts. 1 unit.

491. **Directed Reading.** ¼ to 1 unit; no student may offer more than 1 unit of credit in this course toward the Ph.D. degree. Prerequisite: Second-year graduate standing. STAFF.

495. **Bibliography and Criticism.** Same as Latin 495. Introduction to the methods and techniques of scholarship. ½ unit. OLIVER.

496. **Bibliography and Criticism.** Same as Latin 496. ½ unit. OLIVER.

499. **Thesis Research.** Guidance in writing theses for advanced degrees. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. **Third-Year Greek.** Readings in Attic prose. ½ unit. Prerequisite: Greek 202.

302. **Third-Year Greek.** Continuation of Greek 301. Readings in Greek Tragedy. ½ unit. Prerequisite: Greek 301.

308. Comparative Grammar of Greek and Latin. Same as Latin and Linguistics 308. An historical study of the Greek and Latin languages through use of the comparative method. ½ unit. Prerequisite: Latin 202 or equivalent; credit or registration in Greek 202.

309. The Structure of Greek. A linguistic analysis of the morphology and syntax of the Greek language. ¾ unit. Prerequisite: Greek 202 or equivalent.

391. Readings in Greek Literature. Readings from Greek authors chosen by the instructor chiefly from the following list of authors and topics (others may be chosen): Herodotus, Tragedy, Comedy, Lyric Poetry, Aristotle, Oratory, New Testament, Survey of Greek Literature. ¾ unit. Prerequisite: Greek 302 or equivalent. STAFF.

Latin

Preparation for first-year graduate work in Latin should include at least two years of preparatory Latin and three years of college Latin. A reading knowledge of French and German is important. Some acquaintance with Greek is highly desirable, and the study of history and philosophy is especially recommended.

Candidates for the Master of Arts in the Teaching of Latin must earn four units in Latin, two units in education, and two units in electives. Three of the four required units in Latin must be in courses numbered above 400; the other unit is from Latin 305, 306, 311, 312, or 391. The required work in education consists of Educational Psychology 311 and 312 and one unit selected from History and Philosophy of Education 303, 304, 305. The electives may be in Latin, in Greek, in education, or in other fields. The courses in Latin and the electives must be selected with the approval of the adviser, Professor J. J. Bateman, 361 Lincoln Hall. See pages 36 and 37.

COURSES FOR GRADUATES

In any given semester, a selection from the following courses is offered. Consult the departmental office, 361 Lincoln Hall, well in advance of registration.

Unless otherwise noted, the prerequisite to all courses is three years of college Latin or equivalent.

401. Readings in Latin for Graduate Students. Directed readings, largely in medieval and modern Latin. Designed for graduate students who need to use Latin in their research. Zero credit. Prerequisite: Two years of high school Latin or equivalent.

402. Teaching College Latin. A course designed for new graduate teaching assistants in the Classics Department. New techniques are examined for teaching pronunciation, vocabulary, grammar, and the reading of Latin. Class is closely correlated with the teaching assignments of the graduate students. No credit.

409. History of the Latin Language. 1 unit. Prerequisite: Two years of college Latin or equivalent; two years of a modern foreign language.

410. Vulgar Latin. 1 unit. Prerequisite: Two years of college Latin; two years of a Romance language. HELLER.

411. Latin Epigraphy. 1 unit. Prerequisite: Three years of college Latin or equivalent one year of ancient history. OLIVER.

412. Latin Elegy. 1 unit. OLIVER.

413. Caesar. 1 unit. BATEMAN.

414. Lucan. 1 unit. OLIVER.

415. Lucretius. 1 unit.

416. Vergil. 1 unit. BATEMAN.

417. Ovid. A study of the works of Ovid with special emphasis on literary and philosophic

problems. 1 unit. Prerequisite: Four years of college Latin or equivalent. JACOBSON.

421. Horace. 1 unit.

422. Plautus and Terence. 1 unit.

423. Latin Romance. 1 unit.

425. Cicero. 1 unit.

426. Tacitus. The *Annales*. 1 unit. OLIVER.

427. Roman Satire. 1 unit. HELLER.

441. Latin Paleography. 1 unit.

460. Bibliography and Criticism of Medieval Latin. Introduction to research in Medieval and Patristic Latin. ¾ or 1 unit. Prerequisite: Latin 360, 361, or equivalent. WALLACH.

461. The Medieval Latin Bible. Study of the Vulgate and earlier Latin versions of the Bible and of the commentaries of the Latin Fathers. 1 unit. Prerequisite: Latin 360, 361, or equivalent. WALLACH.

462. The Carolingian Renaissance. Study of the Latin literature of the Carolingian period with emphasis on the work of Alcuin and Charlemagne. 1 unit. Prerequisite: Latin 360, 361, or equivalent. WALLACH.

491. Directed Reading. ¼ to 1 unit; no student may offer more than 1 unit of credit in this course toward the Ph.D. degree. Prerequisite: Second-year graduate standing. STAFF.

495. Bibliography and Criticism. Same as Greek 495. Introduction to the methods and techniques of scholarship. ½ unit. OLIVER.

496. Bibliography and Criticism. Same as Greek 496. ½ unit. OLIVER.

499. Thesis Research. Guidance in writing theses for advanced degrees. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

305. Cicero and the Roman Republic. An advanced course in the writings of Cicero emphasizing the activities of the year 63 B.C., Cicero's consular year. Selected orations and letters of Cicero are read in Latin. Background reading on important figures and events of the late Republic in English. ½ unit. Prerequisite: Latin 201 and 202.

306. An Advanced Course in Vergil. An advanced course in the poetry of Vergil emphasizing the ancient epic as a literary genre and the background study of Roman social, political, and literary history. Selections are read from the *Aeneid*, the *Georgics*, and the *Bucolics*. ½ unit. Prerequisite: Latin 201 and 202. SCANLAN.

307. The Structure of Latin. A linguistic analysis of the morphology and syntax of the Latin language. ¾ unit. Prerequisite: Latin 204 or equivalent.

308. Comparative Grammar of Greek and Latin. Same as Greek and Linguistics 308. An historical study of the Greek and Latin languages through use of the comparative method. ½ unit. Prerequisite: Latin 202 or equivalent; credit or registration in Greek 202.

311. Advanced Latin Composition. Practice in the writing of Latin prose. ½ unit. Prerequisite: Twelve hours of Latin acceptable for a major.

312. Advanced Latin Composition. ½ unit. Prerequisite: Latin 311.

313. Oral Latin. Introduction to the use of Latin as a means of oral communication, with particular reference to instruction in secondary schools. S; ½ unit. Prerequisite: Latin 312 or consent of instructor.

360. Patristic Latin. Literary and historical texts in prose and poetry from Tertullian to Jerome and Augustine. ¾ or 1 unit. Prerequisite: Two years of college Latin or consent of instructor. WALLACH.

361. Medieval Latin. Literary and historical texts in prose and poetry from Cassiodorus to Roger Bacon. ¾ or 1 unit. Prerequisite: Two years of college Latin or consent of instructor. WALLACH.

391. Readings in Latin Literature. Readings from Latin authors chosen by the instructor chiefly from the following list of authors and topics (others may be chosen): Livy, Horace, Vergil, Cicero's *Orations*, Seneca, Ovid, Cicero's *Essays*. Patristic Latin, Medieval Latin. ¾ unit. Prerequisite: Three years of college Latin or equivalent; consent of instructor. STAFF.

COMMUNICATIONS

The program for the Doctor of Philosophy in Communications is administered by an interdepartmental committee in the College of Communications. It provides a core program in communications and permits advanced specialization in several areas: process, content, and effects of the mass media, including their political, social, and economic aspects; advertising; interpersonal communication; psycholinguistics.

The program applies the methods and disciplines of the social sciences, supported by the humanities, fine and applied arts, and natural sciences, to the basic problems of human communications. It is intended for students who plan careers in teaching communication subjects such as journalism, radio-television, and psycholinguistics; scholarly research on the development, control, and ethics of the mass media; experimental research on public opinion measurement; advertising, communication effects, psycholinguistics, and semantics; executive jobs in government and industry requiring breadth, perspective, and a scholarly background.

Prerequisite to admission is a 4.0 grade average and a broad background in the social sciences and humanities. Many of the advanced courses have introductory courses as prerequisites. An introductory course in statistics is generally useful.

The program provides both an introduction to the broad field of communications with its related disciplines (requirements 1, 2, and 4, below), and specialization in a subfield (requirements 3 and 5). The student must meet these detailed requirements:

(1) Communications 471 and 472, Proseminar, two units.

(2) One unit selected from Group A (Communications 414, 432, 444, 462, 468, 470, 473, 474, 481, 483, 307, 308, 344, 360), and one unit from Group B (Communications 420, 424, 425, 426, 436, 456, 325, 351, 352, 370).

(3) An area of specialization in communications. The following are suggested areas: theory of communications, philosophy of communications, communications policies and structures, public opinion and attitude formation, advertising (illustrated by Group A above); interpersonal communication, psycholinguistics (illustrated by Group B above). Occasionally the Committee will approve other specializations. Two units must be taken in courses in research methods; such courses may deal with the philosophical, historical, mathematical, or technical aspects of inquiry and research. Courses for the area of specialization are not limited to courses cross-listed with communications. With his adviser's approval, a student may offer any relevant graduate course as part of the major.

(4) Either a sole minor of four units in a discipline other than communications, or a split minor with three units in a discipline other than communications and three units in a field of communications outside the area of concentration. (If the concentration is in Group A, the minor must be in Group B, and *vice versa*.) Courses cross-listed in communications may not be counted toward a minor in a discipline other than communications.

(5) Communications 499, Thesis Research, eight units.

(6) In some instances, when essential to the student's research program and required by the adviser, high proficiency in one foreign language or in a research skill.

(7) A preliminary written and oral examination.

(8) A final oral examination centered on but not restricted to the field of the dissertation.

Minor. A doctoral candidate wishing to minor in communications should select four,

three, or two units (according to the requirements of his major department). Communications 471 and 472 are recommended as giving a broad survey of theory and research in this area. Candidates minoring in communications are expected to have a social science background for the courses they choose.

Further information may be obtained from the chairman of the administrative committee, Professor James W. Carey, 119 Gregory Hall.

FACULTY

Professors: W. R. Ashby, J. B. Casagrande, S. W. Dunn, J. E. Hulett, J. W. Jensen, R. Merritt, H. L. Mueller, C. E. Osgood, T. Peterson, H. I. Schiller, Rita J. Simon, N. Wedding.

Associate Professors: J. W. Carey (Chairman of Committee on Graduate Study in Communications), M. E. Fishbein, L. A. Jakobovits, H. S. Maclay, J. H. Schacht, Nancy Wiggins.

Assistant Professors: W. K. Archer, W. F. Brewer, T. Guback, P. R. Knights.

COURSES FOR GRADUATES

414. Seminar on Social Interaction. Same as Sociology 414. An analysis of social interaction based on the social psychology of C. H. Cooley, G. H. Mead, and W. I. Thomas. Problems of theory, concepts, and method. 1 unit. Prerequisite: One unit of graduate credit in sociology. Hulett.

420. Seminar in Semantics. Same as Philosophy 420. Intensive study of important contemporary contributions in the fields of semantics, analytic philosophy, and the philosophy of language. $\frac{3}{4}$ or 1 unit. May be repeated for credit.

424. Linguistics and Communication. Same as Linguistics 424. The communicative function of language with emphasis on the application of linguistic theories and methods to problems in human communication. 1 unit. Maclay.

425. Psycholinguistics. Same as Linguistics and Psychology 425. A critical survey of methods and theories in the psychological study of the communication process with emphasis upon linguistic, information-theory, and learning-theory approaches, psycholinguistic analysis of language decoding and encoding, and the development and measurement of symbolic processes, including meaning. 1 unit. Prerequisite: Consent of instructor. Osgood.

426. Research Seminar in Psycholinguistics. Same as Linguistics and Psychology 426. Critical discussion of research problems to which psycholinguistic theories and techniques can be applied. Students taking this course plan, execute, and report an original piece of research in this area. $\frac{1}{2}$ or 1 unit. Prerequisite: Communications 425; consent of instructor. Osgood.

432. Books and Libraries Since the Renaissance. Same as Library Science 432. The study of the developing format of the book, the history of printing, and the growth of libraries in Europe and America since the Renaissance. 1 unit. Krummel, Stevens.

436. Problems of Cybernetics. Same as Biophysics 436 and Electrical Engineering 474. The study of brain-like processes in complex dynamic systems with emphasis on unsolved problems, current developments, and opportunities for research. 1 unit. Prerequisite: Consent of instructor.

444. Seminar in Public Opinion. Same as Sociology 444. Development and theory of public opinion process in society; censorship, interest groups, and propaganda; mass media and public opinion. 1 unit. Simon.

456. Psychology of Social Communication. Same as Psychology 456. Recent developments in method and theory of attitude change through communication; the nature and determinants of informal social communication; the effects of persuasive communica-

tions on public opinion; change in intergroup attitudes through communication. 1 unit. Prerequisite: Psychology 351 or equivalent, or consent of instructor. FISHBEIN.

462. Seminar in Radio and Television. Same as Radio-Television 462. A study of the performance of radio and television in terms of content, government and industry controls, social responsibility, economic bases, and psychological and social effects. 1 unit.

463. World Broadcasting. Same as Radio-Television 463. A study of the broadcast systems used by the nations of the world; alternative and "mixed" systems; international organizations, agreements, exchanges, and problems; broadcasts to and from other countries; implications of such new developments as satellites; mass and non-mass uses. 1 unit. Prerequisite: Radio-Television 462 or consent of instructor.

468. The Political Economy of Communications. Same as Journalism 468. Analysis of the structure, policy, and behavior of such media of communications as newspapers, magazines, books, postal service, telegraph, telephone, broadcasting, and film, with special emphasis on their relationships to political order and the economy. 1 unit. Prerequisite: Consent of College of Communications. GUBACK.

470. Communications and Popular Culture. Same as Journalism 470. Problems of cultural analysis related to the media of communications; social implications of communications research. 1 unit. Prerequisite: Consent of College of Communications. CAREY, GUBACK, SCHACHT.

471. Proseminar in Communications, I. Same as Journalism 471. A general discussion of the mass media of communications, their role as social institutions, their control and support; content, audience, and effect of the mass media. 1 unit. Prerequisite: Consent of College of Communications. CAREY, STAFF.

472. Proseminar in Communications, II. Same as Journalism 472. A general discussion of the problem of communications, including the individual as a communicating system, symbolic processes, analysis of messages, psycholinguistics, and language as social behavior. 1 unit. Prerequisite: Consent of College of Communications. MACLAY, STAFF.

473. History and Theory of Freedom of the Press. Same as Journalism 473. Development of the Anglo-American press system and the idea of freedom of the press; contemporary mass media and their implications for freedom and democracy. 1 unit. Prerequisite: Consent of College of Communications. JENSEN.

474. Communications Systems. Same as Journalism 474. Analysis of the structure and development of communications systems; examination of the role of communication in social change, political movements, and formal organizations. 1 unit. Prerequisite: Consent of College of Communications. CAREY, SCHILLER.

481. Advanced Advertising Principles. Same as Advertising 481. Emphasis is placed on determination and understanding of the principles as related to the science, philosophy, and art of advertising. Students may not receive graduate credit for both Communications 481 and Advertising 388. 1 unit. WEDDING.

482. Research Methods in Advertising and Communications. Same as Advertising 482. A treatment of basic research concepts and procedures in the social sciences with emphasis on advertising and communications. Both nonquantitative and quantitative methods are examined. Prerequisite: A basic course in statistical methods. 1 unit. DUNN.

490. Special Topics in Communications. $\frac{1}{2}$ to 2 units. Prerequisite: Consent of chairman of Committee on Graduate Study in Communications. STAFF.

492. Research Methods in Communications. Same as Journalism 492. An introduction to the methods of empirical research in the behavioral sciences applicable to research problems in human communication, with emphasis on studies of mass communication. Lectures, readings, and laboratory practice. 1 unit. Prerequisite: Consent of College of Communications. WIGGINS.

499. Thesis Research. 0 to 4 units. Students may reregister for a total of eight units. Prerequisite: Consent of chairman of Committee on Graduate Study in Communication and of thesis supervisor. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

307. The Art of the Screen: Narration. Same as Speech 307. Critical study of the adaptation and synthesis of principles of drama, literature, the graphic arts, and music in the evolution of the screen narrative. Lectures, discussions, and reports; viewing of selected films and television programs. ½ unit. Prerequisite: Training in critical approaches to literature, drama, art, or music; consent of instructor. MUELLER.

308. The Art of the Screen: Exposition and Persuasion. Same as Speech 308. Critical study of the application of the eclectic principles of the screen narrative to the transmission of information and the influencing of attitude, opinion, and action. Lectures, discussions, and reports; viewing of selected films and television programs. ½ unit. Prerequisite: Speech 307 or consent of instructor. The prerequisite does not apply to students of library science who have obtained the necessary background through independent reading. MUELLER.

325. Introduction to Psycholinguistics. Same as Linguistics 325. An introductory survey of psychological and linguistic approaches to the study of communication. 1 unit. Prerequisite: An introductory course in linguistics or psychology; consent of instructor. MACLAY.

344. Public Opinion. Same as Sociology 344. Opinion changes and control; propaganda; interest groups and opinion; critical review of methods of measurement. ½ unit. Prerequisite: Sociology 100 or 151. SIMON.

351. Advanced Social Psychology. Same as Psychology and Sociology 351. An integrative treatment of individual behavior variables in relation to group variables. ½ or 1 unit. Prerequisite: Sociology 201 or Psychology 201; Psychology 235 or Sociology 385, or a comparable statistics course. MCGRATH, I. STEINER.

352. Attitude Theory and Measurement. Same as Psychology and Sociology 352. A comprehensive survey of psychological theories of attitude organization and change, and a theoretical and methodological analysis of the various techniques used to measure attitude. These theories and methods are evaluated with respect to empirical research in the area. ½ or 1 unit. Prerequisite: Sociology 201 or Psychology 201; a course in statistics. FISHBEIN.

360. Educational Uses of Television and Radio. Same as Educational Psychology and Radio-Television 360. A study of television and radio as educational instruments, and standards necessary for such use; production, utilization, planning, and evaluation; primary and secondary uses. Identification of the unique contributions and resources of the electronic media, as well as their limitations. Experimentation into new production and utilization techniques designed for educational uses. ½ unit.

370. Language, Culture, and Society. Same as Anthropology and Linguistics 370. An examination of the social and cultural functions of language, with particular emphasis on the application of linguistic methods and findings to selected problems in the social sciences. ½ or 1 unit. BRUKMAN.

COMPARATIVE LITERATURE

The program leading to the degrees of Master of Arts and Doctor of Philosophy in Comparative Literature is designed to make possible a systematic study of subjects and problems common to several literatures. Its purpose is to enable students who have greater than average linguistic competence and preparation to explore (1) the interrelations of several literatures; (2) the main currents, periods, and movements in literary history; and (3) the theory of literature and criticism. The program is supervised by a committee made up of the heads and chairmen of the departments of modern languages and literatures and classics. The student's program of study is supervised by an adviser in the department of his major interest.

A student entering the program should have an undergraduate major in English, classics,

or foreign languages with a grade-point average of at least 4.0 (on a 5.0 scale). Majors in history and philosophy may also be accepted with the special consent of the adviser.

Master of Arts. The candidate must demonstrate a competency in at least two foreign languages as well as in English. Some knowledge of Latin (or Greek) is highly recommended; Latin is necessary for students planning to specialize in the Middle Ages, the Renaissance, or Neo-Classicism. Competency in the languages offered is measured either by the successful completion of one advanced course in the literature of each of the languages chosen or by passing an examination administered by the Program in Comparative Literature with the assistance of an expert in the language concerned. This choice is intended to provide for exotic languages which may not be taught in regular departments.

The candidate must also acquire eight units of credit (general requirement of the Graduate College) including Comparative Literature 401 and one other seminar in Comparative Literature (451, 461, 471, 481). The other six units must be taken in two or three national literatures in a distribution approved by the adviser; at least five of the eight units must be taken in courses at the 400 level. The candidate must also pass a written examination (based on a reading list) which is designed to test his knowledge of literary history as well as his ability to interpret a literary or critical text. In addition he must write a thesis devoted to a problem embracing at least two national literatures.

Doctor of Philosophy. A candidate for the Doctor of Philosophy in Comparative Literature must fulfill the general requirements of the Graduate College including those specified above for the master's degree. He must demonstrate a competency in at least three foreign languages as well as in English. These three languages must coincide with those vital to the student's dissertation and his area of specialization. The candidate must choose at least four units of work from Comparative Literature seminars (451, 461, 471, 481). Four additional units work at the 400 level must be taken in courses regularly offered by the literature departments. The candidate is responsible for a knowledge of the history of the literature in one modern language. He must also select a period of major interest, and be responsible for a knowledge of two other literatures in this period, which are considered as minors. The periods may be (1) Medieval, (2) Renaissance, (3) Neo-Classical and Enlightenment, or (4) Modern (nineteenth and twentieth centuries). He must pass a preliminary examination (a three-part written examination based on his individual program, plus an oral examination), and present a dissertation embracing several national literatures.

FACULTY

Professors: F. Jost (Director of the Graduate Program in Comparative Literature), A. O. Aldridge, J. R. Frey, R. Montano.
Associate Professor: H. Knust.
Assistant Professor: Barbara Smalley.

COURSES FOR GRADUATES

401. Theory of Literature. The methods and objectives of the discipline of comparative literature. 1 unit. Prerequisite: Reading knowledge of two foreign languages; consent of instructor.

451. Seminar in Literary Movements. An investigation of the development and mutation of literary movements (classicism, romanticism, symbolism, etc.) through a study of critical texts and their reception in various countries. The subject of the seminar varies each semester, and it may be taken more than once for a total of three units. 1 unit.

461. Seminar in Literary Forms. A study of a form (the lyric, the novel, the drama, etc.) to discover its essential components in all the literatures studied and the significance of national variations. The subject of the seminar varies each semester, and it may be taken more than once for a total of three units. 1 unit.

471. Seminar in Literary Relations. An investigation of the impact of one literature upon another, or of some specific works upon others (the role of English literature in Conti

nental Europe: the influence of Russian novelists on French and German writers, etc.). The subject of the seminar varies each semester, and it may be taken more than once for a total of three units. 1 unit.

481. Seminar in Literary Themes and Types. A study of a theme or type (the Faust myth, the romantic hero, etc.) to discover its essential components in all the literatures studied and the significance of national variations. The subject of the seminar varies each semester, and it may be taken more than once for a total of three units. 1 unit.

493. Special Studies. 1/4 to 1 unit.

499. Thesis Research. Intended for students engaged in writing a thesis as a partial requirement for the A.M. or Ph.D. degree in Comparative Literature. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

359. The International Folk Tale. Same as English 359. A study of the origin, distribution, and nature of the folk tale with special reference to themes and variants. Representative tales of various areas (Africa, Germany, Greece, India, Ireland, Japan, Norway) are analyzed, and North American Negro and Indian tales are discussed. 3/4 unit.

363. Introduction to Comparative Literature, I. Same as Humanities 363. A one-year course in two parts, offering a survey of methods and goals of comparative literature, illustrated by representative examples taken from several literatures and studies of modern criticism. 3/4 unit.

364. Introduction to Comparative Literature, II. Same as Humanities 364. Continuation of Comparative Literature and Humanities 363. 3/4 unit.

394. Introduction to Folklore: History, Theory, Methods. Same as English, German, Slavic 394, and Speech 346. An introduction to the study of folklore with emphasis on folk cultures in the Old and New World; an historical survey of the development of folklore study, an analysis of the methods and genres of folklore, and an introduction to field collecting and evaluation of archival materials. 3/4 unit. Prerequisite: A reading knowledge of one modern foreign language is recommended.

COMPUTER SCIENCE

The Department of Computer Science offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy in Computer Science. There is opportunity for specialization in circuit design, digital computer arithmetic, switching and automata theory, computer organization, computer applications in physical science, software systems and languages, numerical analysis, pattern recognition, and information retrieval.

The admission average is 4.0 for the last sixty semester hours of undergraduate work. Applicants with an average below 4.0 but above 3.75 are considered on an individual basis. Course prerequisites are twenty semester hours of electrical engineering, mathematics, or physics, including Computer Science 201 and 294, and one course in either Computer Science 301, 387, 391, or their equivalents. Since this is an interdisciplinary program, applicants whose programs are deficient in some of these areas are considered individually.

The requirements for the Doctor of Philosophy degree in Computer Science include satisfactory achievement on a qualifying examination covering the areas of computer design, computer hardware, computer programming, and numerical analysis, in addition to the general requirements of the Graduate College.

The requirements for the Master of Science degree in Computer Science include a thesis and the passing of three of the four areas of the qualifying examination described above, in addition to the general requirements of the Graduate College.

Further details of this program are available from the Department of Computer Science.

or foreign languages with a grade-point average of at least 4.0 (on a 5.0 scale). Majors in history and philosophy may also be accepted with the special consent of the adviser.

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471. Seminar in Literary Relations. An investigation of the impact of one literature upon another, or of some specific works upon others (the role of English literature in Conti-

nental Europe; the influence of Russian novelists on French and German writers, etc.). The subject of the seminar varies each semester, and it may be taken more than once for a total of three units. 1 unit.

481. Seminar in Literary Themes and Types. A study of a theme or type (the Faust myth, the romantic hero, etc.) to discover its essential components in all the literatures studied and the significance of national variations. The subject of the seminar varies each semester, and it may be taken more than once for a total of three units. 1 unit.

493. Special Studies. 1/4 to 1 unit.

499. Thesis Research. Intended for students engaged in writing a thesis as a partial requirement for the A.M. or Ph.D. degree in Comparative Literature. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

359. The International Folk Tale. Same as English 359. A study of the origin, distribution, and nature of the folk tale with special reference to themes and variants. Representative tales of various areas (Africa, Germany, Greece, India, Ireland, Japan, Norway) are analyzed, and North American Negro and Indian tales are discussed. 3/4 unit.

363. Introduction to Comparative Literature, I. Same as Humanities 363. A one-year course in two parts, offering a survey of methods and goals of comparative literature, illustrated by representative examples taken from several literatures and studies of modern criticism. 3/4 unit.

364. Introduction to Comparative Literature, II. Same as Humanities 364. Continuation of Comparative Literature and Humanities 363. 3/4 unit.

394. Introduction to Folklore: History, Theory, Methods. Same as English, German, Slavic 394, and Speech 346. An introduction to the study of folklore with emphasis on folk cultures in the Old and New World; an historical survey of the development of folklore study, an analysis of the methods and genres of folklore, and an introduction to field collecting and evaluation of archival materials. 3/4 unit. Prerequisite: A reading knowledge of one modern foreign language is recommended.

COMPUTER SCIENCE

The Department of Computer Science offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy in Computer Science. There is opportunity for specialization in circuit design, digital computer arithmetic, switching and automata theory, computer organization, computer applications in physical science, software systems and languages, numerical analysis, pattern recognition, and information retrieval.

The admission average is 4.0 for the last sixty semester hours of undergraduate work. Applicants with an average below 4.0 but above 3.75 are considered on an individual basis. Course prerequisites are twenty semester hours of electrical engineering, mathematics, or physics, including Computer Science 201 and 294, and one course in either Computer Science 301, 387, 391, or their equivalents. Since this is an interdisciplinary program, applicants whose programs are deficient in some of these areas are considered individually.

The requirements for the Doctor of Philosophy degree in Computer Science include satisfactory achievement on a qualifying examination covering the areas of computer design, computer hardware, computer programming, and numerical analysis, in addition to the general requirements of the Graduate College.

The requirements for the Master of Science degree in Computer Science include a thesis and the passing of three of the four areas of the qualifying examination described above, in addition to the general requirements of the Graduate College.

Further details of this program are available from the Department of Computer Science.

tual problem solution by the student is accomplished. 1 unit. Prerequisite: Computer Science 101, 103, 107, or 121, and a course in statistics or statistical methods, or equivalent, or consent of instructor.

367. Computer Application to Problems in Mathematics. Computer applications to problems in college level mathematics. Primarily for mathematics teachers. 1 unit. Prerequisite: Computer Science 101, or 107, or 121, or equivalent, or consent of instructor.

385. Theory of Semiconductor Computer Devices. Same as Electrical Engineering 385. Crystal conduction; large signal d-c and transient behavior of semiconductor devices; charge storage theory, phase plane diagrams, tolerance optimization and noise theory; integrated circuits technology: masking, oxidizing, and etching; emphasis on development of device-theoretical background for computer logic design. $^3/_4$ or 1 unit. Prerequisite: Computer Science or Electrical Engineering 294, or consent of instructor.

387. Numerical Analysis. Same as Mathematics 387. The main topics discussed in this course are error analysis and algorithms for: the solution of equations; the computation of eigenvalues and eigenvectors; numerical quadrature; numerical approximation of functions. 1 unit. Prerequisite: Computer Science or Mathematics 287; a knowledge of elementary matrix algebra, or consent of instructor.

391. Boolean Algebra and Switching Theory. Same as Mathematics and Electrical Engineering 391. Boolean algebra with applications to sets, logic, electronic and relay combinational circuits; Karnaugh and Quine-McCluskey minimization procedures with applications; introduction to sequential circuits. 1 unit. Prerequisite: Consent of instructor.

392. Introduction to Automata Theory. Same as Mathematics and Electrical Engineering 392. Semigroups, partially ordered sets, and other algebraic systems; asynchronous machines; abstract synchronous machines and their properties; regular sets; decomposition theory. $^1/_2$ or 1 unit. Prerequisite: Electrical Engineering, Computer Science, or Mathematics 391, or consent of instructor.

393. Digital Computer Circuit Design. Same as Electrical Engineering 393. Design of switching circuits and systems taking into account properties of currently available diodes, transistors, and related circuit elements; applications to slow-speed as well as high-speed computer circuits and data handling links; component tolerance, circuit reliability, and cost factors are considered. 1 unit. Prerequisite: Electrical Engineering 342; Computer Science or Electrical Engineering 294 or 391; or consent of instructor.

394. Logical Design of Automatic Digital Computer Circuits. Same as Electrical Engineering 394. A course in the design of automatic digital computers. Major emphasis is on logical structure of components and the interrelations necessary for automatic operation. 1 unit. Prerequisite: Electrical Engineering 294; consent of instructor.

397. Special Topics in Computer Science. Lecture courses in topics of current interest. Subjects are announced in the Time Table. $^1/_2$ to 1 unit. Prerequisite: Consent of instructor.

DAIRY SCIENCE

The Department of Dairy Science offers graduate work leading to the Master of Science and Doctor of Philosophy. This work is given in five chief fields of specialization: dairy bacteriology and microbiology, dairy biochemistry, dairy cattle feeding and nutrition, dairy cattle breeding and genetics, and physiology of lactation and reproduction.

For admission to full standing, an applicant's undergraduate grade-point average must be at least 3.75.

For a major in dairy science for either advanced degree, students must select, with the advice of the head of the department, a faculty adviser in the separate area of study desired. Candidates for the Master of Science must complete one-half unit of seminar and two units of thesis research. For the Doctor of Philosophy, one and eight units, respectively, of thesis

courses are required. Other course requirements depend upon the area of study in which the student specializes and upon his background training. Information concerning such requirements may be obtained from the departmental office.

Candidates for the Master of Science are expected to complete an acceptable thesis unless the Dean of the Graduate College waives this requirement. All students expecting to continue graduate studies should fulfill the thesis requirements for the master's degree. A comprehensive examination concerning the thesis and the general field of dairy science also is required.

For a minor in dairy science, students should select an adviser in this area of study to determine the specific courses required. For the Master of Science, the minimum requirements for a first minor are two units in dairy science, and for a second minor, one unit in dairy science.

For the Doctor of Philosophy, the minimum requirements for a sole minor are four units of dairy science, of which two units must be in 400-level courses; for a first minor, three units in dairy science; and for a second minor, two units in dairy science.

FACULTY

Professors: K. E. Harshbarger (Head of Department), R. E. Brown, M. P. Bryant, C. L. Davis, R. L. Hays, K. A. Kendall, B. L. Larson, J. R. Lodge, R. W. Touchberry, M. J. Wolin.

Associate Professors: J. H. Byers, C. N. Graves.

Assistant Professor: S. L. Spahr.

COURSES FOR GRADUATES

402. The Microbiology and Physiology of Ruminant Nutrition. The physiological and microbiological aspects of ruminant digestion and their influence on the metabolism of the extraruminal tissues; interpretation of nutritive requirements in terms of rumen microbial activities and evaluation of research techniques. ¾ unit. Prerequisite: Chemistry 350, 355, or equivalent. Brown, Bryant.

408. Physiology of Lactation. The anatomy and endocrinology of mammary development; the environmental, endocrinological, and biochemical factors which affect the yield and composition of milk. ½ to 2 units. Hays.

412. Advanced Endocrinology. Same as Animal Science, Physiology, and Zoology 412. Seminar, lectures, student reports, and discussions of recent advances in endocrinology. This course may be repeated for credit not to exceed a total of two units. ½ unit. Prerequisite: Consent of instructor. Gorski, Nalbandov.

415. Advanced Animal Genetics. Same as Animal Science 415. Genetic theory, analysis of animal breeding problems, genetic results of selection, and different systems of breeding. 1 unit. Prerequisite: Dairy Science 305 or equivalent. Norton.

416. Population Genetics and Animal Breeding. Same as Animal Science 416. The mathematical theory of population genetics and its application to the improvement of farm animals; results of different systems of mating and the expected gains from different methods of selection. 1 unit. Prerequisite: Dairy Science 110 or equivalent. A knowledge of elementary algebra is essential. Touchberry.

430. Physiology of Mammalian Germ Cells. A literature and laboratory course covering the recent theories and developments on the formation, transportation, and livability of spermatozoa and ova within the body, and their metabolism and preservation *in vitro*. 1 unit. Prerequisite: Dairy Science 330, Animal Science 406, and Chemistry 350, or consent of instructor. Lodge.

440. Design and Analysis of Biological Experiments. Same as Agricultural Engineering, Agronomy, Animal Science, Food Science, Forestry, Horticulture, and Veterinary Medical Science 440. Statistical methods as tools for research. Principles of designing experiments and methods of analysis for various kinds of designs, including factorial experiments, are considered from the viewpoint of when and how to use them. ¾ unit. Prerequisite: Dairy Science 340 or equivalent. Seif.

450. Dairy Bacteriology. Assigned laboratory problems in dairy bacteriology. $^1/_2$ to 2 units. Prerequisite: Ten hours of advanced microbiology and/or chemistry; consent of instructor. BRYANT, WOLIN.

481. Animal Biochemical Laboratory Techniques. Same as Animal Science 481. Theory and application of biochemical laboratory techniques to research in the animal-oriented biological sciences. Isolation, characterization, and analysis of biological compounds including enzymes, metabolic intermediates, and cellular components; determination of metabolic pathways and processes. 1 unit. Prerequisite: Chemistry 350 and 355; consent of instructor. LARSON.

490. Dairy Science Seminar. Current literature relating to various phases of dairy science. $^1/_2$ unit. Prerequisite: Graduate major or minor in dairy science. HARSHBARGER.

493. Special Problems. Individual investigations in any phase of dairy science. $^1/_2$ to 2 units. BROWN, BRYANT, BYERS, DAVIS, GRAVES, HARSHBARGER, HAYS, KENDALL, LARSON, LODGE, SPAHR, TOUCHBERRY, WOLIN.

499. Thesis Research. 0 to 4 units. BROWN, BRYANT, BYERS, DAVIS, GRAVES, HARSHBARGER, HAYS, KENDALL, LARSON, LODGE, SPAHR, TOUCHBERRY, WOLIN.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Special Problems. Supervised research on any phase of dairy science, including bacteriology and microbiology, biochemistry, feeding and nutrition, genetics, and physiology. $^1/_2$ or 1 unit. Prerequisite: Approval of head of department. BROWN, BRYANT, BYERS, DAVIS, GRAVES, HARSHBARGER, HAYS, KENDALL, LARSON, LODGE, SPAHR, TOUCHBERRY, WOLIN.

305. Genetics and Animal Improvement. Same as Animal Science 305. The principles of heredity and their application to the problem of animal improvement. $^3/_4$ unit; S, $^1/_2$ unit. Prerequisite: Dairy Science 110 or equivalent. RASMUSEN, TOUCHBERRY.

320. Nutrition and Digestive Physiology of Ruminants. Same as Animal Science 320. The physiology and microbiology of digestion in the ruminant and biochemical pathways of utilization of the absorbed nutrients for productive purposes. $^3/_4$ unit. Prerequisite: Dairy Science or Animal Science 221. DAVIS, HINDS.

330. Reproduction and Artificial Insemination of Farm Animals. Same as Animal Science 330. The anatomy and physiology of reproduction in farm animals, the principles of artificial insemination, and the factors affecting conception in natural and artificial breeding. $^3/_4$ unit; S, $^1/_2$ unit. Prerequisite: Zoology 104; Dairy Science 100 or Animal Science 100. GRAVES, LODGE.

334. Marketing Dairy Products. Same as Agricultural Economics 334. Economic interrelationships of various dairy products; collective bargaining; federal milk orders; mark-up laws, marketing quotas, and other governmental regulations; lowering distribution costs; factors affecting demand and consumption; expanding markets for dairy products. Inspection trip; estimated expense, $5.00. $^3/_4$ or 1 unit. Prerequisite: Agricultural Economics 230, an elementary marketing course, or twelve hours of dairy science or dairy technology. GRUEBELE.

340. Introduction to Applied Statistics. Same as Agricultural Engineering, Agronomy, Animal Science, Food Science, Forestry, Horticulture, and Veterinary Medical Science 340. Statistical methods involving relationships between populations and samples; collection, organization, and analysis of data; techniques in testing hypotheses with an introduction to regression, correlation, and analyses of variance limited to the completely randomized design and the randomized complete-block design. $^3/_4$ unit. Prerequisite: Mathematics 111 or 112 or 104, or equivalent. SEIF.

350. World Animal Agriculture. Same as Animal Science 350. Survey and interpretation of the role of animal agriculture in various cultures of the world with particular reference to underdeveloped countries of the world. The importance of improved animal agriculture for land resource utilization and for meeting food and animal power needs of people are discussed. $^3/_4$ unit. Prerequisite: Consent of instructor.

DANCE

The Department of Dance offers a program of graduate study leading to the Master of Arts in Dance. This program offers advanced work in choreography, dance production, and pedagogy, with emphasis on the related fields of art, music, and theatre.

Admission requirements for a major in this field are: (1) a minimum grade-point average of 3.5; (2) twenty-four semester hours of approved undergraduate credit in dance (at least eight hours), art, music, theatre, and physical education; (3) thirty-six semester hours in humanities (literature, language, and philosophy), natural sciences (biological and physical sciences), and social sciences (history, political science, psychology, anthropology, sociology, education). Applicants lacking a portion of the prerequisites under item (2) may substitute certified experience in dance not to exceed eight semester hours.

Satisfaction of the general requirements for admission to the Graduate College and to this program does not in itself necessarily qualify the student as a degree candidate. The Department of Dance also reserves the right to accept for advanced study only those students whose preparation in dance has been obtained in certain approved institutions.

Of the eight units required for the Master of Arts, a minimum of four must be in dance, or (subject to the approval of the Director of the Graduate Program) in dance and related areas such as art, music, theatre, and speech; two units must be in one or more of the following fields: English, history, philosophy, anthropology, psychology, sociology, radio-television. The remaining two units are for the presentation of an acceptable thesis (Dance 499) and the accompanying noncredit course, Dance 490, Seminar. The thesis may be waived, with the approval of the adviser, but in lieu thereof the candidate must submit two units of course work (total of eight units), plus a recital of solo and group dances which he has choreographed and staged.

Not later than midpoint in the student's program, his work is reviewed in order to determine his status in terms of progress, ultimate completion, and awarding of the degree. The Department of Dance may extend the residence requirement (or increase the total requirements) at this time or any other time, if this seems warranted.

FACULTY

Professor: Margaret Erlanger (Director of Graduate Program).
Associate Professors: Janis Simonds (Head of Department), Beverly Blossom, W. W. Ward, Jr.

COURSES FOR GRADUATES

400. Problems in Dance Education. Basic historical, philosophical, and scientific foundations and developments in dance education; teaching methods; development of compositional problems; creative methods of instruction; organizational problems of dance groups and public dance performance. 1 unit. Prerequisite: Dance 243 or 244, or equivalent. Staff.

401. Choreography. Experience in choreographing a minimum of one solo and one group composition to be presented at the end of the semester. ½ to 2 units. Prerequisite: Dance 345 or equivalent. Students may re-register for a maximum of two units with the permission of the head of the department. Staff.

490. Dance Seminar. Student presentation of thesis reports in dance; informal discussions, demonstrations, lectures, and critical analysis of current problems in dance by professional guests. No credit. Staff.

499. Thesis Research. Preparation of theses in dance. ½ to 2 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

340. History of Dance, I. A survey course tracing dance from its beginnings in primitive societies through the nineteenth century. ¾ to 1 unit.

341. History of Dance, II. A survey course tracing the development of dance in the twentieth century. Prerequisite: Dance 340. ¾ to 1 unit.

345. Dance Production Workshop. Experience in choreography and production of group compositions with special emphasis on staging, lighting, and costuming. $\frac{3}{4}$ to 1 unit. Prerequisite: Dance 264 or consent of instructor.

346. Theory and Philosophy of Dance. A study of the relationship of aesthetic principles and dance theory to a philosophy of dance in education and of dance as a performing art. $\frac{3}{4}$ to 1 unit. Prerequisite: Dance 340 or consent of instructor.

350. Dance Repertory Workshop. Experience in learning, rehearsing, and perfecting concert dance pieces under the direction of experienced choreographers. $\frac{1}{2}$ or 1 unit; may be repeated for a maximum of 2 units. Duplicate registration permitted. Prerequisite: Enrollment in advanced technique course; consent of instructor.

351. Special Problems. Special projects in research or creative investigation taught on an individual basis. $\frac{1}{2}$ or 1 unit; may be repeated for a maximum of 1 unit. Duplicate registration permitted. Prerequisite: Consent of instructor.

360. Advanced Technique, II. Advanced modern dance technique. $\frac{1}{2}$ unit; S, $\frac{1}{4}$ unit. May be repeated for a maximum of 1 unit. Prerequisite: Dance 260 or consent of instructor.

365. Advanced Composition. Work in advanced composition for the experienced student choreographer, including performance of at least one work. $\frac{1}{2}$ unit. Prerequisite: Dance 164 and 264, or consent of instructor.

ECONOMICS

The Department of Economics offers graduate work leading to the Master of Arts, Master of Science, and Doctor of Philosophy.

A student who applies for admission to graduate study in economics must have a grade-point average of 4.0 or higher. Students with averages between 3.75 and 4.0 are considered on an individual basis. Applicants must have completed fifteen hours of undergraduate work in economics or have approval of the Chairman of Graduate Studies. The department recommends that the results of the Graduate Record Examination Aptitude Test accompany application for admission to the Graduate College. Information concerning the dates and places for taking this examination may be secured by writing to the Educational Testing Service, Box 955, Nassau Street, Princeton, New Jersey 08540.

The candidate for an advanced degree in economics may specialize in the following fields of economics: economic theory, history of economic thought, monetary theory and policy, public finance and taxation, growth and development, international economics, labor economics, economic history, comparative economic systems, transportation, econometrics, urban and regional economics, industrial organization, and mathematical economics.

Master of Arts or Master of Science. The following requirements must be met:

(1) Economic Theory. Two units of course work, consisting of 400-401, or 402-403; if the student has had 300-301 or their equivalent, he must take 402-403.

(2) Statistics. Proficiency in statistical analysis. This requirement may be met by taking Economics 470 or by passing a proficiency examination.

(3) History of Economic Thought or Economic History. The student may meet this requirement by taking one unit in either field or by passing a proficiency examination.

(4) Course work beyond that required to bring the total to eight units, two of which must be master's thesis work; or successful completion of all the requirements to take the Ph.D. qualifying examinations.

Doctor of Philosophy. The following requirements must be met:

(1) Economic Theory. Economics 402-403, plus one additional 400-level course in advanced economic theory.

(2) Statistics. The same demonstration of proficiency as for the master's degree.

(3) History of Economic Thought and Economic History. One unit in each field, or passing a preliminary examination.

(4) Specialized Fields. The student must select three additional fields, two of which must be in economics. The third may be outside the department. At least two units of graduate work in courses in each field selected are normally required.

(5) Additional units to bring the total to twenty-four, of which eight must be doctoral dissertation units.

The candidate is required to pass an oral and written preliminary examination in economic theory and each of the three specialized fields prior to beginning dissertation research, and an oral final examination covering his research. There is no general foreign language requirement; however, individual students may be required to demonstrate foreign language competence, if such competence is needed for their dissertation research.

FACULTY

Professors: M. Frankel (Chairman of Department), V L. Bassie, R. Brandis, H. J. Brems, J. F. Due, R. Ferber, D. P. Flanders, H. Folk, R. W. Harbeson, A. J. Heins, D. R. Hodgman, G. G. Judge, D. L. Kemmerer, H. O. Nourse, D. W. Paden, J. B. Parrish, J. D. Phillips, P. Schran, J. L. Simon, K. Taira, T. Takayama, P. J. Wells.

Associate Professors: Grace Beckett, R. W. Gillespie, F. M. Gottheil, P. T. Hartman, W. W. McMahon, R. W. Resek, F. R. Shupp, C. M. Sprenkle, S. W. Steinkamp, Janet L. Weston, T. A. Yancey.

Assistant Professors: R. J. Arnould, R. W. Cummings, R. Husby, J. Leuthold, J. R. Millar, M. E. Moyer, L. Neal, P. Uselding, R. Vandendries, S. Wallack, L. E. Weiser, H. F. Williamson, P. Yeung.

COURSES FOR GRADUATES

400. General Economic Theory. Emphasis in this course is placed on micro-economic theory. The principal topics include: a review of value and distribution theory, the theory of choice by household and firms, general micro-economic theory; and theoretical developments of current interest. Attention is given to empirical studies intended to affirm or disaffirm economic principles. Intended for minors in economics and others who have a minimum preparation for graduate study in economics. 1 unit. Prerequisite: Economics 102, 103, or 108. Flanders.

401. General Economic Theory. Emphasis in this course is placed on macro-economic theory and the relationship of economics to the other social sciences. The principle topics include: a review of Keynesian macro-economic theory, formal growth theory, selected business cycle theory, the theory of socio-economic change, and an outline of the differentiation and integration of economics and other social sciences. Intended for minors in economics and others who have a minimum preparation for graduate study in economics. 1 unit. Prerequisite: Economics 102, 103, or 108. Flanders, Staff.

402. Economic Theory. This course develops modern micro-economic theory: utility functions and demand; production functions and cost; linear programming; price and nonprice policy by the firm; market equilibria; income distribution; general equilibrium including input-output analysis. The course is given in two sections, one offering a primarily mathematical presentation, the other, a primarily literary presentation. 1 unit. Prerequisite: Economics 300, 301, or equivalent; for the mathematical section, a knowledge of algebra and calculus. Staff.

403. Economic Theory. This course develops modern macro-economic theory; the Keynesian model of employment, interest, and money; its extension to international trade; fiscal policy and macro-economic theory of distribution; the consumption function; the theory of growth and cycles in terms of difference and differential equations. This course is given in two sections, one offering a primarily mathematical presentation, the other, a

primarily literary presentation. 1 unit. Prerequisite: Economics 300, 301, or equivalent; for the mathematical section, a knowledge of algebra and calculus. STAFF.

406. History of Economic Thought. An analysis of economic thought from the Physiocrats to the present; the materials selected are evaluated both as reflections of their times and as contributions to contemporary economic thought. 1 unit. Prerequisite: Economics 300 and 301, or equivalent. BRANDIS.

408. Philosophical Problems in Economics. The study of philosophical problems in economics, with some emphasis on the methodology and epistemology of economic theory. The views of leading economists are used to show the development of broad philosophical problems of economic theory, the relation of theory and certain of its applied areas, and the relation of economics to other selected disciplines. These problems are treated in the light of modern scientific philosophy. Offered in 1970-1971 and in alternate years. 1 unit. Prerequisite: One unit either in economic theory or in the history of economic thought.

410. Price and Distribution Theory. A research-oriented seminar in micro-economic theory. Major topics treated include: comparative static analysis of demand, production, and the theory of markets; dynamic equilibrium; market dynamics. Sub-topics include axiomatics of preferences; ordinal and Bernoullian utility, revealed preference, and the interdependence of preferences; multiperiod production, utility, and consumption; the aggregation of micro-economic relationships; expectations and response lags; analysis of changing market structures; game theory. Offered in 1970-1971 and in alternate years. 1 unit. Prerequisite: Economics 402 and 470, or equivalent.

411. Capital and Interest Theory. A comprehensive and critical examination of the theory of capital and interest as the subject has been developed by the leading English and continental writers. Special attention is given to the optimal investment decision of the firm, capital accumulation and the efficient utilization of society's resources, and to the relation between capital and interest. Offered in 1971-1972 and in alternate years. 1 unit. Prerequisite: Economics 403 or consent of instructor. BREMS, SPRENKLE, WELLS.

412. Advanced Aggregate Income Theory. An analysis of the theory of income and employment with emphasis upon the measurement of income and product, money flows, and the relationship between input and output in the economy. Offered in 1971-1972 and in alternate years. 1 unit. Prerequisite: Economics 403 or consent of instructor. BREMS, PADEN, WELLS.

413. Consumption Theory. The theory of consumer behavior in modern economic analysis. Utility analysis at the micro level, consumer interdependence and problems of aggregation, econometric tests, aggregate consumption analysis in static and dynamic contexts, and the implications of the theory of consumer behavior for cyclical movements and economic growth. Offered in 1970-1971 and in alternate years. 1 unit. Prerequisite: Economics 400 or 402, or consent of instructor. FERBER, MCMAHON.

414. Public Finance. Analysis of government expenditures and decision making; the budgetary process; fiscal policy; government borrowing and debt management; intergovernmental fiscal relations; pricing of government services; public finance in developing economies. 1 unit. Prerequisite: Six hours of economics. DUE, HEINS.

415. Economics of Taxation. Principles of taxation; incidence and distribution of tax burden; economic analysis of the major taxes: the personal and corporate income taxes, sales and excise taxes, property tax, and others; taxation and economic development. 1 unit. Prerequisite: Six hours of economics. DUE, HEINS.

420. Monetary Theory. A critical examination of monetary theories and their neoclassical antecedents. Among the topics considered are the quantity theory, liquidity preference, the demand for money, velocity, theories of the level and term structure of interest rates, asset theory, and money in static and dynamic macro-general equilibrium models. 1 unit. Prerequisite: A course in income and employment theory or consent of instructor. HODGMAN, SPRENKLE.

421. The Theory of Monetary Policy. Theories of central banking, debt management, financial intermediaries, and the monetary behavior of firms and households are used to explore current issues in the theory of monetary policy. Current empirical research is reviewed with particular emphasis on econometric studies of monetary behavior. 1 unit. Prerequisite: A course in money and banking, in macro-economic theory, calculus, and statistics, or consent of instructor. HODGMAN, SPRENKLE.

425. Macro-Accounting. Same as Accountancy 455. An examination of the fundamental concepts underlying the attempt to measure the economic activities of macro-units; similarities and contrasts of accounting problems, theoretical and practical, of the business enterprise and of national or regional units in relationship to existing systems of accounting measurement; macro-accounting statements and analyses; usefulness of macro-accounting techniques and data in evaluating national and regional goals. 1 unit. Prerequisite: Intermediate macro-accounting theory or consent of instructor.

428. International Trade Theory. The neoclassical theory of international trade is developed and then used for the analysis of tariffs, customs, unions, and the effects of trade on the distribution of income and welfare. The relations between the balance of payments and national income are analyzed and used to study the role of income changes combined with price changes in the balance of payments adjustment process. 1 unit. Prerequisite: Economics 300 and 301, or equivalent. GILLESPIE, WEISER.

429. International Trade Policy. Concepts of balance of payments equilibrium, the foreign exchange market and the theory of capital movements; current problems and policies related to balance of payments desequilibrium, trade policy, and the functioning of the international monetary system. 1 unit. Prerequisite: Economics 300 and 301, or equivalent. CUMMINGS, GILLESPIE.

436. American Economic History. Colonization, westward movement, agriculture, transportation, industrial revolution, trust movement, slavery, labor conditions and organizations, capital growth, money and banking, foreign and domestic commerce, and social progress. Material chiefly since 1790. Not open to students who have had Economics 236. 1 unit. KEMMERER.

438. Economic History of Europe. The major lines of development since 1450; comparative study of forces and institutions inimical or favorable to growth; selected readings on organization of economic activity, role of governments and the entrepreneur, commercial policy, monetary systems, land tenure, process of capital formation, industrialization, etc. 1 unit. Prerequisite: Consent of instructor.

440. Labor Economics. Same as Labor and Industrial Relations 440. A survey of recent trends in the labor force, of real and money earnings, and of the distribution of national income. This review of recent trends in these areas is used as the basis for a critical economic analysis of contemporary English and American wage theory. 1 unit. Prerequisite: Economics 300 and 301.

441. Labor Economics. Same as Labor and Industrial Relations 441. The economic issues and implications involved in hours of work, employment and unemployment, and trade union institutionalism (the impact of the trade union upon the basic institution of a free enterprise economy). Emphasis in all cases is upon the development of appropriate public policy. 1 unit. Prerequisite: Economics 300 and 301.

442. Collective Bargaining. Same as Labor and Industrial Relations 442. The development of a theory of the continuing interactions between unions and management which define and modify the role of each and the terms of employment. Appropriate social science concepts are used. Emphasis is on the negotiating process, the structure of bargaining, and such issues as wages, worker security, and management authority as well as on the interactions between the parties and governmental process. 1 unit. Graduate credit is not given for both Economics 343 and Economics or Labor and Industrial Relations 442. Prerequisite: Consent of instructor.

443. Problems and Practices of Labor Dispute Settlement. Same as Labor and Indus-

trial Relations 443. Seminar in the policies and practices of labor contract administration; comparative study of the fundamentals of grievance handling, analysis of mediation and fact-finding techniques; and special emphasis on the use of arbitration as a means of reducing industrial conflict. 1 unit. Prerequisite: Consent of instructor. McPherson.

444. Economics of Manpower Resources. Same as Labor and Industrial Relations 444. Emergence of the manpower resource issue; population as a resource base: the labor force; measurement and characteristics, behavior under changing income, employment, technology; women as the dynamic factor in labor force growth; problems of utilization of labor force components; intellectual resources, older workers, manual, white collar, Negro, marginal forces; issues of national manpower policy. 1 unit. Graduate credit is not given for both Economics or Labor and Industrial Relations 345 and Economics or Labor and Industrial Relations 444. Prerequisite: Consent of instructor. Parrish.

447. Labor Union Organization and Administration. Same as Labor and Industrial Relations 447. Analysis of the structure, functions, and government of the modern American trade union movement. Provides a survey of the environmental factors, objectives, and action programs with considerable emphasis on economic as well as internal institutional factors, including the roles of leaders, policy determination and execution, jurisdictional disputes, and governmental regulations. 1 unit. Prerequisite: Major in social science or consent of instructor. Garman.

450. The Economics of Development and Growth. Review and analysis of the theories and patterns of growth in developed and underdeveloped economies. The problems and methods of measuring growth are considered, the variables thought to be strategic in the growth process are critically examined, and the policy implications of different theories are explored. 1 unit. Prerequisite: Economics 300 and 301, or equivalent. Frankel.

451. The Developing Economies. An analysis of the newly-developing economies, with emphasis on institutional factors affecting development, and economic policy relating to development. 1 unit. Prerequisite: Economics 450. Staff.

455. Comparative Economic Systems. A comparative analysis of the structures and policies of market-directed and planned economies. 1 unit. Prerequisite: Economics 103 or 108 or equivalent.

457. Economic Planning in the Soviet Union and Eastern Europe. An intensive examination of the structure and performance of the Soviet and the East European economies, emphasizing analysis of the main theoretic and operational dimensions of economic planning; choice, design, and efficacy of central planning instruments are evaluated from both theoretical and historical perspectives. 1 unit. Prerequisite: Economics 357, 450, or 455, or a reading knowledge of Russian. Millar.

460. Location Theory. The theory of location of economic activity in modern economic analysis; production and location theories are synthesized and applied to regional structure and interregional and international trade and development. 1 unit. Graduate credit is not given for both Economics 360 and 460 or 461. Prerequisite: Economics 300 and 301, or equivalent. Nourse.

461. Urban and Regional Economic Development. Measurement and analysis of interregional differences in economic growth. 1 unit. Graduate credit is not given for both Economics 360 and 460 or 461. Prerequisite: Economics 300 and 301. Nourse.

467. Mathematical Economics, I: Statics. A study of quantitative techniques useful in economic analysis and decision making. Mathematical programming, input-output analysis, point-set theory and game theory, existence, optimality and stability conditions for static general equilibrium, activity analysis, including welfare economics. 1 unit. Prerequisite: Mathematics 315; Economics 402, 403; or equivalent.

468. Mathematical Economics, II: Dynamics. A study of quantitative techniques useful in economic analysis and decision making. Single and systems of difference and differential equations, dynamic programming, Pontryagin maximum principle, interaction of multiplier and accelerator, von Neumann model, Turnpike theorem, growth models,

control systems. 1 unit. Prerequisite: Mathematics 315; Economics 402, 403; or equivalent.

470. Economic Statistics. Classical statistics and regression analysis; descriptive statistics, probability, point and interval estimation, decision theory, variance analysis, linear regression, and least squares estimates. 1 unit. Prerequisite: Consent of instructor.

471. Economic Statistics. Part 1: the construction of econometric models; characteristics of models and choice of estimating methods; estimates of parameters by various methods. Part 2: Bayesian statistics and decision theory. 1 unit. Prerequisite: Economics 470 or equivalent. YANCEY.

473. Economic Forecasting. Forecasting techniques; analysis of important forecasting situations in terms of strategic forces and relationships; the place of judgment in evaluating current information, selecting critical factors, and appraising the validity of analytical techniques. Offered in 1970-1971 and in alternate years. 1 unit. Prerequisite: Economics 171 and 312 or 373 or equivalent. BASSIE.

476. Econometrics, I. Estimation of parameters for single equation models; tests of hypotheses and confidence regions for regression models; large sample theory in single equation models; Bayesian statistics in regression models. 1 unit. Prerequisite: Mathematics 315 and 363. JUDGE, RESEK, YANCEY.

477. Econometrics, II. Specification of models with systems of simultaneous equations; identification problem, distributed lag models, K-class estimators, maximum likelihood estimators, three-stage least squares, and effects of specification errors are considered. 1 unit. Prerequisite: Economics 476. JUDGE, RESEK, YANCEY.

479. Research Seminar in Quantitative Economics. Significant work in the area of quantitative economics is reported and explored by members of the instructional staff, by guest speakers from academic, governmental, and industrial centers, and by graduate students in the second year of their work who are assigned projects. Offered in 1970-1971 and in alternate years. 1 unit. Prerequisite: The equivalent of one year of graduate statistics (theoretical or applied), calculus, and the equivalent of one year of mathematical economics. FERBER.

480. Industrial Organization. Theory of the organization of markets and firms, behavior of firms, functioning of competitive systems, performance of markets. 1 unit.

481. Industrial Organization and Public Policy. The economic aspects of public policy relating to the maintenance of competition, public utility regulation, and natural resource regulation. A survey of other forms of regulation and market organization in other countries. 1 unit. Prerequisite: Economics 480.

484. Economics of Transportation. A study of the principal economic problems arising in connection with the development and regulation of railroads and other modes of transport. 1 unit. HARBESON.

485. Economics of Transportation. A study of the principal economic problems arising in connection with the development and regulation of railroads and other modes of transport. 1 unit.

490. Individual Study and Research. Directed reading and research. $\frac{1}{2}$ to 1 unit. STAFF.

499. Thesis Research. Preparation of thesis required of all students writing master's or doctor's theses in economics. 0 to 4 units; S, 0 to 2 units. Master's theses, FLANDERS; doctor's theses, DUE.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Intermediate Micro-Economic Theory. Micro-economic analysis including value and distribution theory. Topics include the analysis of demand, the theory of the firm and the industry, and the analysis of the pricing of the factors of production. Each topic is integrated in a micro-general equilibrium context which builds toward explaining the

resource allocation process. ½ unit. Credit is not given for both Economics 200 and 300. Prerequisite: Economics 103 or 108.

301. Intermediate Macro-Economic Theory. The modern theory of the determination of the level and rate of growth of income, employment, output, and the price level. Alternate fiscal and monetary policies to facilitate full employment and economic growth are discussed. ½ unit. Prerequisite: Economics 103 or 108.

302. Economic Analysis. An introduction to the theory of income and employment, price and allocation, and instability and growth. S; ½ or 1 unit. Prerequisite: Economics 108, enrollment in National Science Foundation Summer Institute in Economics, or consent of instructor. PADEN.

306. History of Economic Thought. A study of the development of economics. Contributions of schools of thought and individual writers are examined in their settings and as they influenced economic thought and national policy. ½ unit. Prerequisite: Economics 103 or 108.

312. Economic Dynamics and Growth. An analysis of the causes of economic instability; the requirements for economic growth in the national economy, and a consideration of public policy relating to instability and growth. ½ or 1 unit. Prerequisite: Economics 108 or 103 and 301.

313. Economics of Consumption. Same as Home Economics 313. An analysis of the macro and micro aspects of consumption. ½ or 1 unit. Prerequisite: Economics 102 or 108; a course in applied statistics. DUNSING.

315. The Economics of Poverty and Income Maintenance. Same as Labor and Industrial Relations 315. An economic analysis of the nature and causes of poverty with special emphasis on critical evaluation of programs to combat poverty in the United States. ½ or 1 unit. Prerequisite: Economics 103 or 108.

328. International Economics. An introduction to the theory of international trade and finance with selected application to current problems of commercial policy, balance of payments adjustment, and the international monetary system. ½ or 1 unit. Prerequisite: Economics 103 or 108.

329. Contemporary Issues in the International Economy. Analysis in depth of selected current issues and policy problems of the international economy. The topics may include but not be restricted to the following: new approaches to the theory of international trade, reform of the international monetary system, role of the General Agreement on Trade and Tariffs and United Nations Commission on Trade and Development in expanding trade between developed and undeveloped economies, problems of stabilizing international commodity markets, balance of payments problems of the United States and other selected countries. ½ or 1 unit. Prerequisite: Economics 328 or equivalent.

335. American Financial History. American monetary history and the development of the present monetary system, the rise of commercial, investment, and central banking and of other financial institutions, and the financing of government, especially of major wars. ½ or 1 unit. Prerequisite: Finance 250. KEMMERER.

337. Economic History of American Agriculture. Same as Agricultural Economics and History 337. The development of American agriculture from early colonial times to the present. Emphasis on regional development, evolution of methods and equipment, trends in marketing and credit, and the making of federal farm policy. ¾ or 1 unit. Prerequisite: A college-level course in basic economics or American history.

341. The Economics of Labor Markets. Same as Labor and Industrial Relations 341. A study of the theory and empirical research in wage determination, wage structure, economic effects of unions and macro-economic labor market problems. Topics include: determinants of interindustry and occupational wage differentials; aggregate labor supply functions; effects of unions on relative wages; cost-push inflation; wage-price-unemployment dilemma models; disguised and structural unemployment; employment and income policies. ½ or 1 unit. Prerequisite: Economics 103 or 108.

343. Unions, Bargaining, and Public Policy. Same as Labor and Industrial Relations 343. Analysis of the legal background and economic issues associated with unions and collective bargaining in the United States. Includes theory of the labor movement; processes of union wage determination; analysis of strikes; background, strategies and principal issues in collective bargaining; problems and policies of government intervention. ½ or 1 unit. Graduate credit is not given for both Economics 343 and Economics or Labor and Industrial Relations 442. Prerequisite: Economics 103 or 108.

345. Economics of Manpower. Same as Labor and Industrial Relations 345. Manpower training in economic growth, labor force characteristics, occupational structure and future manpower requirements, job information networks, economics of discrimination and underutilization, national manpower policies and programs, private industry and union manpower planning. ½ or 1 unit. Graduate credit is not given for both Economics or Labor and Industrial Relations 345 and Economics or Labor and Industrial Relations 444. Prerequisite: Economics 103 or 108.

349. Senior Seminar in Labor Economics. Pre-professional capstone course intended to unify other courses in labor economics and closely related fields. Included are studies of research techniques and sources; individual readings in current literature; preparation of research reports and papers; consideration of professional employment opportunities and graduate study in labor economics and industrial relations. ½ or 1 unit. Prerequisite: Economics 240; consent of instructor. PARRISH.

350. The Developing Economies. An analysis of the economic problems associated with newly developing nations. Emphasis is placed on a study of their economic structures, their factor scarcities, and their programs for development. Not open for graduate credit for graduate candidates in economics. Graduate credit is not given for both Economics 350 and 450 or 451. ½ or 1 unit. Prerequisite: Economics 108 or 102 and 103.

352. Economic Development in Latin America. Same as Agricultural Economics 352. A study of economic activity and the process of diversification and industrialization in Latin America, with comparative analysis of selected countries. ½ or 1 unit. Prerequisite: Economics 103 or 108, or consent of instructor.

353. Economic Development in India and Southeast Asia. Same as Agricultural Economics 353. Analysis of plans and progress toward economic development in India and Southeast Asia; economic characteristics of the area and their significance for economic development. ½ or 1 unit. Prerequisite: Economics 103 or 108, or consent of instructor. CUMMINGS.

354. Economic Development of Tropical Africa. Same as Agricultural Economics 354. Types of African economies and growth of the exchange economy; development of natural resources, industry, trade, finance, and education; analysis of economic integration, governmental planning, and development projects; demographic, land tenure, and institutional influences on development. ½ or 1 unit. Prerequisite: Economics 103 or 108, or consent of instructor.

357. The Soviet Economy. Analytical survey of Soviet economic development; structure and performance of the economy; problems of planning and control. ½ or 1 unit. Prerequisite: Economics 103 or 108, or consent of instructor. HODGMAN.

358. The Economy of China. Discussion of changes in the patterns of production, exchange, and distribution in Communist China, with emphasis on their relation to social transformation. Survey of Chinese economic history over the past century, dealing with the institutional background to and the structure of economic activities in China. ½ or 1 unit. Prerequisite: Economics 103 or 108, or consent of instructor. SCHRAN.

360. Regional Economic Development. A survey of the theory and problems of regional economic development, including regional accounts, interregional income and trade theory, principles of the location of economic activity, theories of regional growth, and public policy for development of regions. A student receiving credit for Economics 360 may not receive credit for Economics 460 or 461. ½ or 1 unit. Prerequisite: Economics 103 or 108. NOURSE.

367. Mathematical Economics, I. Mathematical reformulation and interpretation of traditional economic theory. ½ to 1 unit. Prerequisite: Mathematics 143 and Economics 300 and 301, or equivalent.

368. Mathematical Economics, II. Introduction to linear and nonlinear economic models. Emphasis is placed on the formulation and interpretation of modern economic theory and welfare economics. ½ to 1 unit. Prerequisite: Mathematics 124 or 315; Mathematics 143; Economics 300 or equivalent.

384. Economics of Transportation. Economic aspects of the transportation industry with special emphasis on problems of regulation and public policy. ½ or 1 unit. Prerequisite: Economics 103 or 108. HARBESON.

386. Current Transportation Problems. An analytical and critical study of selected problems of current interest in transportation. ½ or 1 unit. Prerequisite: Economics 384 or consent of instructor. HARBESON.

389. Industrial Competition and Monopoly. The organization and tactics of market control, the development of antitrust law and policy, public policy regarding competitive practices, special policies applying to natural resource industries, and regulated monopoly and government ownership at alternatives to the antitrust approach. ½ or 1 unit. Prerequisite: Economics 103 or 108. HARBESON.

EDUCATION

(Including Educational Administration and Supervision, Educational Psychology, Elementary Education, Higher Education, History and Philosophy of Education, Secondary and Continuing Education, Special Education, and Vocational and Technical Education)

The graduate student who majors in education may specialize in administration and supervision, agricultural education, education of exceptional children, educational psychology (including a special program in psychology of classroom learning and instruction), elementary school teaching, early childhood education, teaching of reading, guidance and counseling (including rehabilitation counseling), history and philosophy of education (including comparative education and social foundations of education), measurement and evaluation, research methods, school psychology, or any of the fields of secondary school education: English, home economics, industrial education, mathematics, modern languages, physical education, science, and social science.

Admission to graduate and professional degree work in education requires a grade-point average of 3.5 or higher and undergraduate preparation appropriate to advanced study in the chosen major. Applicants who hold bachelor's degrees in fields other than teacher education are considered on an individual basis. See admission requirements for the Master of Education.

Master of Arts or Master of Science in Education. In addition to the general rules of the Graduate College (see pages 30 to 37), the following regulations apply to programs leading to the Master of Arts or Master of Science in Education:

(1) A minimum of eight units, including a thesis of not more than two units is required.

(2) Extramural course work is not applicable toward these degrees.

(3) Competence in certain fields is required, and may be demonstrated either by satisfactory grades in required courses or by satisfactory completion of proficiency examinations on those courses. History and Philosophy of Education 304 and 305, and Educational Psychology 311 and 312 are required.

Doctor of Philosophy. To become a candidate for the Doctor of Philosophy with a major in education, the applicant must hold a master's degree with a major in education or some appropriately related subject. An applicant who has not written a master's thesis is required to prepare and submit a paper equivalent to a master's thesis. The applicant should present credentials well in advance of his first registration. Required examinations and other steps preliminary to admission must be completed prior to the registration period. Admission is not complete until the student has been accepted by an adviser.

The general requirements of the Graduate College pertaining to the Doctor of Philosophy must be met (see pages 37 to 39). In addition to the general requirements of the College of Education, the candidate must also successfully complete, prior to the oral preliminary examination, one of the following research options: foreign language, computer science, statistics and measurement, social science methods, analytic philosophy methods, or social philosophy methods. Other options may be elected by petition to the Graduate Programs Committee of the College of Education.

Each doctoral candidate in the College of Education should complete an approved supervised professional work experience that consists of at least one-half time work for a semester as a part of his graduate program in education. This requirement is to be completed during the period between admission and completion of degree requirements. An appropriate work experience will be defined by the student's adviser and will be related to the student's past experience and future goals. This requirement supplements rather than duplicates any prior work experience. Among experiences which satisfy this requirement are college-level teaching as a graduate teaching assistant or instructor, supervision of student teachers, counseling or clinical activity, research assistantships, curriculum development activity, and administrative assistantships and internships.

PROFESSIONAL DEGREES

These degrees are designed for teachers, supervisors, administrative officers, and others engaged in educational work demanding broad, fundamental, and practical preparation and the ability to utilize professionally the contributions of research and philosophy.

Master of Education.

Admission. In addition to general requirements, the credit presented for admission must include sixteen semester hours in education with a grade-point average of 3.5 for all education courses.

Applicants holding bachelor's degrees in fields other than teacher education may be considered individually for admission to the program leading to the Master of Education. Applicants admitted with deficiencies in professional education or for teacher certification will be required to take a limited number of undergraduate courses. Such courses will not be counted in the eight units of graduate work required for the Master of Education.

In general, the professional education requirements for the Master of Education and for teacher certification may be fulfilled through proficiency examination in Educational Psychology 211, an appropriate methods course at the undergraduate level, student teaching, History and Philosophy of Education 304 and 305, and Educational Psychology 311 and 312. However, an applicant admitted with deficiencies should expect to take additional courses in the teaching subject fields.

Those preparing for teaching at the secondary level must have completed a minimum of thirty-two semester hours of appropriate course work in the first teaching field, if elected, and from twenty to twenty-four semester hours of credit in a second teaching field. Previous course work in such fields will be evaluated and considered in determining the eligibility of a student for teacher certification.

Graduate students admitted with deficiencies for teaching in the elementary schools will be required to complete Illinois teacher certification requirements through appropriate undergraduate and graduate course work.

The advisers of students admitted with deficiencies will develop programs in which a maximum number of teacher certification requirements are met through courses also acceptable in fulfillment of master's degree requirements. Students admitted with no deficiencies can complete requirements for the Master of Education through full-time study in two semesters. However, students admitted with deficiencies for certification should anticipate from one to two additional semesters of course work.

Program. At least eight units of course work, including four units in education, are required. History and Philosophy of Education 304 and 305 and Educational Psychology 311 and 312 are required, except from students who pass proficiency examinations in these courses.

There may be one or two minors. In general, candidates for the Master of Education are expected to take at least two units in fields other than education, particularly if the specializa-

tion is in secondary education. One unit at the 300 level in the teaching subject or subjects may be substituted for one of the three units at the 400 level otherwise required. Courses at the 200 level in the teaching subject or subjects may be taken for graduate credit subject to the prior approval of the Dean of the Graduate College, but total credit in such courses may not exceed two units. Credit earned in such courses can not be applied to the requirements for the Master of Arts, Master of Science, Doctor of Education, or Doctor of Philosophy.

Residence. At least four units must be earned while the student is in residence on the Urbana campus. The residence requirement may be met by spending two eight-week summer sessions as a full-time student. Students whose employment does not allow eight weeks of summer session attendance may earn one unit while in residence for four weeks and may satisfy the residence requirement in four summer sessions of four weeks each.

Advanced Certificate in Education.

Admission. A master's degree from an accredited institution, plus a minimum of two years' successful professional employment in education are required.

Program. A year of specialized professional study is required. Of the eight units of course work required, at least four must be in courses at the 400 level. Students who have not previously taken History and Philosophy of Education 304 and 305 and Educational Psychology 311 and 312, or equivalents, must take them or pass proficiency examinations. Course work may be taken in minor subjects under regulations similar to those stated above for the Master of Education. The program must be approved by the adviser and submitted in writing to the College of Education office before the student's first registration is completed.

Credit earned by a candidate for the Advanced Certificate is not accepted as meeting requirements for the Doctor of Education or the Doctor of Philosophy.

Residence. The residence requirement is similar to that for the Master of Education.

Doctor of Education. Programs leading to the Doctor of Education are designed to provide advanced professional training and develop further ability in the scholarly study of professional problems. These programs are intended primarily for students pursuing careers in which teaching, administration, or school services predominate rather than those in which research predominates.

Admission. A candidate for admission must hold a master's degree from an accredited institution. Applicants for admission should present credentials well in advance of the date for their first registration. Admission is determined by examination, personal interviews, record of previous education and experience, and recommendation from persons who have known the candidate.

A student may transfer from the Doctor of Education program to the program for the Advanced Certificate in Education prior to the completion of five units.

Program. Sixteen units of course work beyond the master's degree are required. Extramural course work may not be included in this sixteen-unit requirement. (Exceptions may be made for Educational Psychology 413 and Educational Administration and Supervision 461, 462, and 463.) A student who has completed course work beyond the master's degree at the University of Illinois or at another accredited institution may petition for the application of not more than six units of such work toward the program leading to the Doctor of Education. A student may, with the approval of his adviser, plan a maximum of four units of work to be accomplished at other accredited institutions. A minimum of ten units must be earned in courses taken at Urbana.

History and Philosophy of Education 410 and Educational Psychology 415 and 390 are required (note prerequisites). Each Ed.D. student is required to pass, with a grade of B or better, Educational Psychology 390, Elements of Educational Statistics, except that competence may be demonstrated by passing a proficiency examination or an advanced course in statistics in lieu of 390.

A preliminary examination must be passed prior to beginning the dissertation. A student must complete at least eight units of course work subsequent to his admission and must pass a comprehensive written examination before he may enter the oral preliminary examination.

Prior to admission to the preliminary examination, the student is expected to demonstrate competence in the psychology of learning, psychology of adolescence or child growth and development, psychology of adjustment or mental hygiene and the school, social psy-

chology, social foundations of education, philosophy of education, history of American education, and comparative education. Competence may be demonstrated by satisfactory grades or by satisfactory completion of proficiency examinations.

Thesis. The Ed.D. candidate, with the consent of his adviser, presents (1) a dissertation of the same type expected for the Ph.D.; (2) a field study; (3) a scholarly and original dissertation dealing in an analytical and critical manner with some educational problem or policy issue; or (4) a scholarly and original paper dealing with the interpretation and evaluation of the work of some writer where that work has a significant bearing on any aspect of the educational enterprise and where that significance has not been clearly indicated by earlier studies. A candidate is expected to enroll in 499 (Thesis) for a number of units that adequately reflects his research load and the use he makes of staff time and facilities. No minimum number of units of 499 (Thesis) is required. General regulations of the Graduate College covering the examinations, filing of thesis titles, and the preparation, submission, and publication of theses must be met.

Residence. Minimum residence requirements are (1) two consecutive semesters, at least three units each, or (2) one semester, at least three units, and the summer session immediately preceding or following, at least one and one-half units, plus an additional summer session, at least one and one-half units.

Professional Work Requirement. Each doctoral candidate in the College of Education should complete an approved supervised professional work experience that consists of at least one-half time work for a semester as a part of his graduate program in education. This requirement is to be completed during the period between admission and completion of degree requirements. An appropriate work experience will be defined by the student's adviser and will be related to the student's past experience and future goals. This requirement supplements rather than duplicates any prior work experience. Among experiences which satisfy this requirement are college-level teaching as a graduate teaching assistant or instructor, supervision of student teachers, counseling or clinical activity, research assistantships, curriculum development activity, and administrative assistantships and internships.

Doctor of Education in Art Education. Doctor of Education candidates whose major field of study is art education follow programs for which the College of Education and the Department of Art share responsibility. Each student works under the joint direction of two faculty advisers, one from the College of Education and one from the Department of Art. For further information, see page 90.

Doctor of Education in Music Education. Doctor of Education candidates whose major field of study is music education follow programs of study for which the College of Education and the School of Music share responsibility. Each student works under the joint direction of two faculty advisers, one from the College of Education and one from the School of Music. For further information, see page 306.

SCHOOL PSYCHOLOGY

Students who seek specialized preparation for work as school psychologists may become candidates for either the Doctor of Education or the Doctor of Philosophy. Doctor of Philosophy candidates may major in either education or psychology, though every student who is preparing to become a school psychologist must include in his program of study extensive work in both education and psychology. The doctoral program of study for school psychologists requires a minimum of three years of graduate study plus twelve months as an intern.

A student's acceptance and his work in this program are subject to review by the Joint Committee on School Psychology representing the College of Education and the Department of Psychology.

Students may also seek specialized preparation for work as school psychologists and be candidates for the Advanced Certificate in Education. This program, requiring two full academic years and the intervening summer session of work, more than meets the requirements of most states in preparing for the full year of internship, which usually is required for state certification at the examiner level. In addition to the work in education and psychology, courses in special education and reading are required. A master's degree can be obtained in

the course of the program; the Advanced Certificate in Education is awarded at the completion of it.

SPECIAL EDUCATION

Graduate study in special education is available at the master's degree, advanced certificate, or doctoral levels. Masters' degree programs require one to two years and are designed primarily to prepare teachers of the culturally deprived, deaf, emotionally disturbed, gifted, mentally retarded, and children with learning disabilities. The Advanced Certificate requires at least a year of study beyond the master's degree and emphasizes preparation for supervision and administration of programs of special education. Doctoral programs require three or more years of advanced graduate study and are designed to prepare administrators, college instructors, and researchers in the various fields of special education indicated above. Special admission requirements apply to all graduate programs in special education. Further information concerning programs, admission requirements, and financial assistance may be obtained from the Chairman of the Graduate Selection Committee, Department of Special Education, 210 Education Building.

CLASSROOM LEARNING AND INSTRUCTION

Students planning to specialize in research and/or collegiate instruction in the educational psychology of classroom learning and instruction may become candidates for either the Doctor of Philosophy or the Doctor of Education. Doctor of Philosophy candidates major in education and minor in psychology or take a split minor with psychology and a related area, such as communications, or a subject such as mathematics, chemistry, or social studies. The program of study for the doctorate degree requires a minimum of three years of graduate study, including six months of internship. After an applicant is admitted, his study program is subject to review by one of the advisers associated with the program. A required core program consists of Educational Psychology 412, 449, 490, 492, 496, 497, and Psychology 418 and an internship of six months' minimum duration. The doctoral dissertation is generally written in the area of the nature, conditions, and improvement of classroom learning and instruction.

REHABILITATION COUNSELING

Students pursuing the Master of Education degree who plan to specialize in counseling and guidance normally require two academic years to complete this program, the fourth semester being devoted to supervised practice in an agency or institution located away from the campus. Doctoral programs also may be arranged to emphasize the study of rehabilitation counseling. Further information may be obtained from the Division of Counseling and Guidance, College of Education.

FACULTY

Professors: J. M. Atkin (Dean of the College of Education), E. W. Anderson, R. C. Anderson, F. P. Barnes, M. Beberman, W. C. Becker, S. W. Bijou, G. M. Blair, P. Braunfeld, H. S. Broudy, J. R. Burnett, R. W. Burnett, C. B. Cox, M. D. Durkin, J. A. Easley, R. N. Evans, B. Farber, F. H. Finch, J. G. Froehlich, N. E. Gronlund, J. T. Hastings, P. E. Hemp, K. B. Henderson, R. A. Henderson, L. G. Humphreys, J. M. Hunt, W. P. Hurder, R. S. Jones, Merle B. Karnes, M. R. Karnes, W. V. Kaulfers, G. C. Kettelkamp, Colleen J. Kirk, C. G. Knapp, K. M. Lansing, Celia B. Lavatelli, H. H. Lerch, T. Manolakes, J. E. McGill, C. J. McIntyre, W. P. McLure, F. McMurray, L. E. Metcalf, J. O. Miller, P. E. Miller, W. J. Moore, T. E. Newland, C. H. Patterson, A. J. Peshkin, L. J. Phipps, R. E. Pingry, W. R. Powell, S. P. Quigley, F. M. Raubinger, S. Rosen, H. A. Schultz, J. H. Shores, R. H. Simpson, J. M. Slater, B. Spodek, R. E. Stake, W. O. Stanley, M. R. Sumption, M. Tatsuoka, L. R. Tucker.

Associate Professors: L. M. Aleamoni, E. F. Anderson, T. S. Baldwin, R. Brown, J. H. Burnett, R. J. Colwell, D. J. Delaney, T. Denny, E. L. Everetts, Jo Ann Fley, L. R. Goulet, O. E. Gould, W. D. Johnson, Laura J. Jordan, H. R. Kaczkowski, M. L. Maehr, Mary E. Mather, H. A. Moses, T. J. Sergiovanni, Miriam Shelden, W. L. Shoemaker, P. B. Shoresman, R. A. Smith, Hazel T. Spitze, H. J. Sredl, J. Stern, R. A. Tinkham, R. M. Tomlinson, K. J. Travers, J. L. Walker, R. W. Walker, R. E. Williams, Barbara A. Yates, J. S. Zaccaria.

Assistant Professors: F. D. Carver, R. A. Chadbourn, G. M. Clark, S. Cohen, W. Feinberg, A. Grotelueschen, L. G. Katz, K. R. Koenke, T. J. Long, M. J. Masucci, R. J. Menges, T. O'Banion, Margaret J. Phillips, P. S. Riegel, W. M. Rogge, J. A. Salvia, W. M. Stallings, W. M. Steinman, J. L. Wardrop, C. K. West.

Educational Administration and Supervision

COURSES FOR GRADUATES

430. Elementary School Organization and Administration. Principal focus of this course is given to conceptual analyses of administrative and supervisory functions of the elementary school. Examination is made of administrative roles in the design, implementation, and improvement of the total educational program. Intensive use is made of research skills and strategies in the investigation of problems of instruction. In summer sessions this course is restricted to those without experience in administration and must be taken with Educational Administration and Supervision 464. Intended primarily for candidates for the master's degree. 1 unit. Prerequisite: Consent of instructor.

438. Instructional Supervision. Methods, theories, and research applying to supervision at all levels of public education. Analyses are made concerning the work of curriculum directors, general supervisors, special supervisors, supervising principals, and department heads. Study of supervisory methods, current plans for staff utilization, use of instructional materials, evaluation of educational programs, and evaluation of the effects of supervision are stressed. 1 unit. Prerequisite: Elementary Education or Secondary and Continuing Education 439; Educational Administration and Supervision 460. Carver, Sergiovanni.

440. Administration and Supervision of Junior and Senior High Schools. Principal focus of this course is given to conceptual analyses of administrative and supervisory functions of the secondary schools. Problems are then projected through case studies and situational descriptions as a means of examining tasks and processes in such areas as curriculum and instruction, pupil and staff personnel, student activities, school organization, and management and school-community relationships. In summer sessions this course is restricted to those without experience in administration and must be taken with Educational Administration and Supervision 464. Intended primarily for candidates for the master's degree. 1 unit. Prerequisite: Educational Administration and Supervision 460 or consent of instructor. Raubinger.

449. Independent Study. To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. $\frac{1}{2}$ or 1 unit. No more than two units may be offered toward an advanced degree except by consent of the Dean of the College of Education. Prerequisite: Approval of study outline by adviser and the department chairman prior to enrollment.

460. Public Control and Administration of Education. A course to provide the basic common understanding of theory and practice in operation and control of schools useful to teachers and other citizens. The course serves as an introductory course for prospective

administrative officers and supervisors. Not open to experienced administrators nor to students who have taken any of the following courses (or equivalents): Educational Administration and Supervision 430, 440, 461, 462, 464, 465, 466. 1 unit. CARVER, MILLER, RAUBINGER.

461. Administration of Educational Programs and Personnel. Study of principles and criteria for analysis of programs at various levels of operation, such as instructional departments and pupil personnel service units, individual schools, local school systems, intermediate units, state education departments, and the federal government. Similar study is given to analysis of personnel requirements at various levels of operation. Educational Administration and Supervision 461, 462, and 463 constitute the required core program for all students specializing in educational administration who are candidates for a degree beyond the master's. 1 unit. Prerequisite: Educational Administration and Supervision 460 and 430 or 440. CARVER, MILLER, SERGIOVANNI.

462. Organization and Business Administration of Public Education. Organization and operation of public school government; functions and processes of school business administration, including internal organization of the division of business services; scope and role of the business manager, budgetary processes, accounting and financial reporting, contracts, liability, insurance, purchasing, auxiliary services, salary policies, and methods of survey, evaluation, and planning. 1 unit. Prerequisite: Educational Administration and Supervision 460, 430 or 440, and 461. BURNHAM, MCLURE, RAUBINGER.

463. The Role of Administrative Leadership. Study of principles underlying administrative leadership drawn from such disciplines as philosophy, psychology, sociology, and public administration. Application of these principles in the analysis and formulation of general procedures by which the process of administration may be carried on most effectively to develop and operate efficient educational programs. 1 unit. Prerequisite: Educational Administration and Supervision 461, and Educational Psychology 413. CARVER, MILLER, SERGIOVANNI.

464. Field Problems in Educational Administration. Designed to give direct experience in the study of educational problems of concern to administrators. Each student selects and pursues one or more problems of study under the supervision of a professor. 1 unit. Prerequisite: Consent of instructor. STAFF.

465. Personnel Administration. Principles, problems, and trends in the administration of professional public school personnel: organization of personnel; assessment and definition of personnel needs; recruitment, selection, and induction; evaluation; personnel development programs; and teacher organizations. 1 unit. Prerequisite: Educational Administration and Supervision 460, 430, 440, and 461. SERGIOVANNI.

466. Public School Finance. Advanced graduate study of the theory and technology of public school finance. Attention is centered on analysis of principles and theory underlying fiscal practice in various states; technical knowledge of designing controls, organization, and fiscal systems in harmony with expressed theory; and the application of research to the analysis of problems related to the improvement of financing public schools. 1 unit. Prerequisite: Educational Administration and Supervision 462 or consent of instructor. MCLURE.

468. School-Community Relations. Study of the relationship of the American school to the community. Analysis of the power structure, social agencies, school liaison groups, and economic character of the community as they affect and are affected by the school. Includes an evaluation of the various media of communication between the school and the larger community, and the development of criteria for an effective program of school-community relations. 1 unit. SUMPTION.

469. Legal Basis of School Administration. The legal rights, privileges, responsibilities, immunities, and authority of pupil, parents, teachers, administrators, and school board members in relation to the school. 1 unit. SUMPTION.

470. Principles and Resources for School Plant Planning. Study of principles for planning functional school buildings. Primary emphasis is placed on the planning process involved in meeting the building needs of the school district, including (1) analysis and projection of educational programs to be housed, (2) prediction of pupil enrollments, (3) site selection, (4) educational specifications of buildings, and (5) rehabilitation, remodeling, and modernization of existing buildings. 1 unit. Prerequisite: Educational Administration and Supervision 460. WILSEY.

490. Seminar for Advanced Students of Education. Seminar in educational administration and supervision open only to persons who have been admitted for doctoral study in educational administration and supervision. 1 to 2 units. STAFF.

491. Field Study and Thesis Seminar. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyse critically all presentations. Limited to students who have been admitted for doctoral study. 1 to 2 units. STAFF.

499. Thesis Research. Individual direction of research and thesis writing. 0 to 4 units. STAFF.

Educational Psychology

COURSES FOR GRADUATES

411. Psychology of Adolescence for Teachers. The psychological significance of adolescence, its biological and social foundations, and its implications for education. 1 unit. Prerequisite: Educational Psychology 311 and 312. BLAIR, DELANEY, GOULET, JONES, WEST, ZACCARIA.

412. Advanced Child Development for Students of Education. A consideration of the nature of the child and his development during the preschool and elementary school years, with emphasis on development as a process of social learning; interpretation of the scientific literature as it concerns the educative process; discussion of methods of studying and evaluating the behavior of the child as an individual and in group situations. 1 unit. Prerequisite: Educational Psychology 311 and 312. COHEN, JONES, WOLFF.

413. Social Psychology and the Problems of Education. A consideration of the concepts and methods of social psychology as they apply to the professional functions of teachers, administrators, and other persons engaged in education. Opportunity to work upon field problems is provided. 1 unit. Prerequisite: Educational Psychology 311, 312, and 390. MAEHR, R. H. SIMPSON.

414. The Psychology of College Teaching. Designed particularly for graduate students minoring in education or preparing for college teaching. Psycho-educational problems in undergraduate and graduate teaching, with special emphasis upon individual differences, remedial procedures, principles of learning, the technology of teaching and learning, adjustment problems of college students, counseling and advisory services, test construction, analysis and use of test results and resource materials in this field. 1 unit. Prerequisite: A course in psychology; consent of instructor. MENGES, R. H. SIMPSON.

415. Psychological Theories Applied to Education. An advanced course in human behavior required of all candidates for the degree of Doctor of Education. Special attention is given to contemporary systems of psychology and their relationship to educational practice. 1 unit. Prerequisite: Educational Psychology 311 and 312; Educational Psychology 411 or 412; candidacy for Ed.D. or Ph.D. in Education. BLAIR, JONES, MAEHR, WEST.

422. Counseling Theory and Practice. Study of counseling processes that are especially applicable to the problems of normal individuals. Theories of education of education and personality which underlie counseling procedures are studied for the purpose of develop-

ing the student's ability to evaluate these procedures. 1 unit. Prerequisite: Educational Psychology 311 and 312. DELANEY, KACZKOWSKI, LONG, SHOEMAKER, SLATER.

423. The Use of Tests in Counseling. Practice in interpreting test results in case studies; study of the implications on test choices and usage of the philosophic orientation of the counselor, the type of case, the case setting, and the case information available; discussion of the advantages and disadvantages of particular tests for given types of cases. 1 unit. Prerequisite: Educational Psychology 392, and 422, or equivalent. HASTINGS, KACZKOWSKI, PATTERSON, PHILLIPS.

424. Supervised Practice in Educational Psychology. Study of the individual client through the use of the tools of the counselor. Each student is expected to develop professional skills by working with clients. 2 units. Prerequisite: Master's degree in guidance; consent of faculty committee. STAFF.

425. Principles and Practices of Student Personnel Services. For teachers, administrators, student advisers, and others who are interested in basic guidance principles and in guidance methods useful to schools and to agencies dealing with out-of-school youth and adults. Considers the role of guidance specialists and the guidance functions of community agencies. 1 unit. STAFF.

427. Principles and Techniques of Group Counseling. A study of the principles of group guidance and their application. Includes a review of the historical development of group guidance and the study of pertinent research. Discussion and role playing have an important part in the work of the course. Case materials are utilized. 1 unit. Prerequisite: Educational Psychology 311, 312, 422, 423, and 425; or consent of instructor. KACZKOWSKI, LONG, MASUCCI.

428. Theories of Career Development and the Use of Occupational Information. Deals with the results of recent occupational research and with the use of these results by teachers and counselors. Attention is given to research techniques suitable for use in local occupational studies. 1 unit. Prerequisite: Educational Psychology 425 or an introductory course in counseling. KACZKOWSKI, MASUCCI, MOSES, SHOEMAKER, ZACCARIA.

429. Field Instruction in Educational Psychology. Individual instruction designed to help the advanced student apply the basic principles of counseling. Each student is assigned to a counseling agency. 1 or 2 units. Prerequisite: Educational Psychology 422 and 424 (with consent of instructor, registration in Educational Psychology 424 may be concurrent). STAFF.

447. Seminar in Rehabilitation Counseling. Problems of rehabilitation, including problems associated with specific physical and mental disabilities. Critical examination of literature pertaining to rehabilitation, with emphasis on recent publications. May be repeated for a maximum of one unit. $\frac{1}{2}$ unit. Prerequisite: Educational Psychology 326 and 422. MOSES, PATTERSON.

449. Independent Study. To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. $\frac{1}{2}$ or 1 unit. No more than two units may be offered toward an advanced degree except by consent of the Dean of the College of Education. Prerequisite: Approval of study outline by adviser and the department chairman prior to enrollment.

490. Seminar for Advanced Students of Education. Seminar in educational psychology open only to persons who have been admitted for doctoral study in educational psychology. 0 to 2 units. STAFF.

491. Field Study and Thesis Seminar. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to students who have been admitted for doctoral study. 1 to 2 units. STAFF.

492. Psychology of Learning and Instruction. Same as Psychology 492. An advanced course in the nature and conditions of long-term cognitive learning and retention in classroom and similar situations. This course is intended for doctoral students with a special interest in research leading to the improvement of classroom teaching and learning, in psychological aspects of curriculum research, and in the cognitive aspects of military and industrial training. 1 unit. Prerequisite: Consent of instructor. ANDERSON.

494. Multivariate Analysis in Psychology and Education. Same as Psychology and Sociology 494. The principal methods of descriptive statistics used in the analysis of multiple measurements, with emphasis on conventional procedures of factor analysis; profile similarity models; discriminatory analysis; multi-dimensional scaling. 1 unit. Prerequisite: Psychology 307 or Educational Psychology 496; consent of instructor. TUCKER, WARDROP.

495. Theory of Measurement. Same as Psychology 495. Logical and mathematical principles underlying test design, construction, and validation, with particular emphasis on evaluating reliability of measurement, utility resulting from test-based decisions, and validity of descriptions of individuals. 1 unit. Prerequisite: Educational Psychology 496 or Psychology 307, or equivalent; Educational Psychology 392 or Psychology 290, or equivalent. STAKE, TUCKER, WARDROP.

496. Statistical Methods in Education. First graduate course in statistical methods in education. Includes an introduction to the logic of scientific method in education; probability and sampling in education, correlation methods in educational measurements and research; partial and multiple correlation and the testing of statistical hypotheses; and other applications of statistics to educational research. 1 unit. Prerequisite: Educational Psychology 390. ALEAMONI, CHADBOURN, PINGRY, STAKE, TATSUOKA.

497. Advanced Statistical Methods in Education. An advanced course in statistical methods applied to educational research. Analysis of variance and co-variance, experimental design, introduction to multivariate statistical techniques including discriminant analysis. 1 unit. Prerequisite: Educational Psychology 496. TATSUOKA.

498. Theory of Educational Evaluation. Study of relationship between educational purposes, curriculum, and evaluation through emphasis on principles of evaluation dealing with classifications of behavior. A detailed study of the concept of test validity, of its determination, and of its relation to test design, with emphasis on the evaluation of outcomes involving the higher mental processes. Guided practice in solving complex problems of evaluating behaviors, some in subject matter areas but primarily those cutting across subject matter lines. 1 unit. Prerequisite: Educational Psychology 496. HASTINGS, SPENCER, STAKE.

499. Thesis Research. Individual direction of research and thesis writing. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. Psychology of Learning for Teachers. A consideration of learning situations in the light of psychological findings and concepts. Development of a theory of learning, and its application to the teaching of attitudes, skills, and understanding. ½ unit. Prerequisite: Educational Psychology 211; practice teaching or teaching experience. STAFF.

312. Mental Hygiene and the School. An examination of social and emotional adjustment. Study of normal personality, integration, feelings of inferiority, adjustment mechanisms, classroom therapy, behavior disorders in children, and introduction to methods of child study and provision for emotionally disturbed children. ½ unit. Prerequisite: Educational Psychology 211; practice teaching or teaching experience. STAFF.

313. Programmed Instruction. The design, production, and evaluation of self-instructional materials, including delineation of objectives, task analysis, frame writing, frame editing, pilot testing and revision, and field testing; survey of current research and

orientations toward programmed instruction; consideration of the mechanized and text forms for presenting programs. Each student prepares a self-instructional program. 1 unit. Prerequisite: Educational Psychology 311. ANDERSON.

326. Introduction to Vocational Rehabilitation Counseling. A survey of the history and development of vocational rehabilitation programs; contributions of related disciplines and their integration; basic procedures and problems of vocational rehabilitation counseling. ½ unit. Prerequisite: Consent of instructor. MOSES, PATTERSON.

339. Corrective Reading. Same as Elementary Education 339. Practice in administering and interpreting group diagnostic reading tests; instructional techniques appropriate for less severe reading disabilities. 1 unit. Prerequisite: Elementary Education 336 or 338. BENNETT, POWELL.

343. Individual Intelligence Testing. The fundamental concepts relevant to the general problem of the individual testing of learning aptitude. Acquisition of psychometric competence in the use of the 1960 Binet and the Wechsler tests. Acquaintance and limited practice in the administration, scoring, and interpretation of results obtained by means of performance scales and other devices appropriate for use with individuals having sensory, associative, and/or motor impairments. 1 unit. Prerequisite: Consent of instructor and six hours of psychology; Special Education 324 or Educational Psychology 392 or Psychology 390, or equivalent. MCGUIRE, NEWLAND, PHILLIPS.

360. Educational Uses of Television and Radio. Same as Communications and Radio-Television 360. A study of television and radio as educational instruments, and standards necessary for such use; production, utilization, planning, and evaluation; primary and secondary uses. Identification of the unique contributions and resources of the electronic media, as well as their limitations. Experimentation into new production and utilization techniques designed for educational uses. ½ unit. MCINTYRE.

390. Elements of Educational Statistics. Designed for terminal value for professional training of students not intending to pursue advanced graduate work, and for introductory value for students continuing graduate study in education. The course includes descriptive statistics, introduction to correlation and regression, the normal curve, statistical inference, and the presentation and interpretation of statistical data in educational literature. 1 unit. Prerequisite: Educational Psychology 211 or 236. ALEAMONI, CHADBOURN, HASTINGS, LOEB, PINGRY, STAKE, TATSUOKA.

391. Construction and Use of Tests in Teaching. Includes the relationship of classroom testing to educational objectives and the curriculum; the construction, administration, and scoring of the various types of essay and short-answer tests; and other means of measuring the attainment of objectives and marking procedure. Designed primarily for classroom teachers. 1 unit. Prerequisite: Educational Psychology 211 or 236. GRONLUND, HASTINGS, SPENCER.

392. Introduction to the Principles of Measurement. Study of the selection, preparation, administration, and interpretation of psychological and educational tests and diagnostic devices, with emphasis on theory at a beginning level and with application to hypothetical school situations as a teaching device. Sources of standard tests, criteria for their evaluation, methods of scoring, interpretation, and general and special areas are considered. 1 unit. Prerequisite: Educational Psychology 211 or Elementary Education 236. GRONLUND, HASTINGS, KACZKOWSKI, SPENCER, STAKE.

Elementary Education

COURSES FOR GRADUATES

431. Elementary School Classroom Programs. An exploration of organizational centers for determining selection and sequence of educative experiences in the elementary school classroom. The role of the teacher in curriculum construction is emphasized. 1 unit. STAFF.

432. Clinical Diagnosis and Remediation in Reading. Supervised experience in the Reading Center; special attention is given to evaluative and interpretative techniques in cases of severe reading disabilities based on the analysis of specific readings needs. 1 unit; may be repeated for a maximum of 2 units. Prerequisite: Elementary Education 339 and a course in individual mental testing. KOENKE, POWELL.

433. Curriculum Problems and Trends in Special Fields of Elementary Education. A study of the place of the various special fields of elementary education in the emerging elementary school curriculum, with a review and analysis of recent trends and research findings in these fields. Sections are usually offered in the following fields: (a) language arts, (b) social studies, (c) mathematics, (d) science, (e) creative arts, (f) reading, (g) early childhood education, (h) teacher education. 1 unit. Prerequisite: For all sections, Elementary Education 431 or 434, or consent of instructor; for the section in language arts, Elementary Education 333 and 336, or a course in the teaching of reading or language arts, or consent of instructor; for the section in creative arts, Elementary Education 337 or consent of instructor; for the section in science, Elementary Education 335 or a methods course in teaching science in the elementary school and two years of college science, or consent of instructor; for the section in reading, Elementary Education 336 or a course in teaching of reading; for the section in early childhood education, Elementary Education 434 or consent of instructor. STAFF.

434. Programs in Early Childhood Education. An advanced course intended primarily for teachers and supervisors of younger children, ages three to eight. Presents a review and analysis of research findings, experimentation, and current trends in curriculum organization, procedures, and materials essential to developing classroom programs for children. 1 unit. KATZ, LAVATELLI, SPODEK.

435. Diagnosis and Correction in Elementary Mathematics. The nature, causes, and correction of mathematical difficulties at the elementary level; process of evaluation through group and individual procedures; the development and use of diagnostic instruments and corrective techniques; supervised experience with pupils having difficulties. 1 unit; may be repeated for a maximum of 2 units. Prerequisite: Elementary Education 332; Educational Psychology 392; or equivalent. LERCH.

436. Field Instruction in Reading Programs. Provides for directed practice in the area of reading; students are placed in an approved and supervised field position for part of the semester. 1 unit. Prerequisite: Elementary Education 432. KOENKE, POWELL.

437. Methods of Child Study. A study of ways in which teachers can evaluate child behavior and development. Particular emphasis is placed on classroom application. Instruction and practice in the use and interpretation of observations, anecdote records, rating scales, interviews, achievement tests, intelligence tests, questionnaires, sociometric and projective techniques. 1 unit. Prerequisite: Educational Psychology 312 or consent of instructor. KATZ, LAVATELLI, SPODEK.

438. The Organization and Supervision of School Reading Programs. Study of procedures for planning, improving, and evaluating reading programs on a systemwide basis. Open only to those persons who are preparing to supervise reading programs or with approval of graduate adviser. 1 unit. Prerequisite: Elementary Education 339 or Educational Psychology 339; Elementary Education 433 (reading section). KOENKE, POWELL.

439. Fundamentals of Curriculum Development. Designed to explore and clarify the several theoretical bases offered in educational literature for each of the major aspects of curriculum planning, to indicate the forms implementation of these theories have assumed in practice, to reduce these theoretical and practical differences to fundamental issues, to encourage critical evaluation of both the theories and practices from the standpoint of logical and empirical evidence, and to project, on the basis of such analysis, needed research, present best practice, and ultimately desirable programs. 1 unit. MCGILL, SHORES.

449. Independent Study. To offer opportunity and challenge of self-directive, independent

study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by consent of the Dean of the College of Education. Prerequisite: Approval of study outline by adviser and the department chairman prior to enrollment.

455. Theories of Art Education. A study of the major theories of art education and an analysis of the most significant research in the field. Emphasis is given to a critical evaluation of theory and research and to the application of such studies to current problems in art education in the public schools. 1 unit. Prerequisite: Elementary Education 337 or Secondary and Continuing Education 456, or consent of instructor. LANSING.

459. Workshop in Curriculum Development. Curriculum development projects in specialized fields of elementary education. 1 to 2 units. STAFF.

490. Seminar for Advanced Students of Education. Seminar in elementary education open only to persons who have been admitted for doctoral study in elementary education. 1 to 2 units. STAFF.

491. Field Study and Thesis Seminar. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to students who have been admitted for doctoral study. 1 to 2 units. STAFF.

499. Thesis Research. Individual direction of research and thesis writing. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

332. Principles and Practices in Elementary Mathematics Education. Organization, scope, and sequence of the elementary mathematics program and the functional nature of mathematics; methods, techniques, experiences, and materials of value in teaching elementary mathematics, and the role of the classroom teacher. ½ or 1 unit. Prerequisite: Mathematics 202 and 203 or equivalent. LERCH.

333. The Teaching of Language Arts in the Elementary School. Concerns itself with goals, content, and teaching problems involved in the devising of programs in the area of elementary school language arts that are cumulative and sequential from kindergarten through the elementary school. ½ to 1 unit. Prerequisite: Elementary Education 237; Educational Psychology 236. EVERTTS, MOORE.

334. Principles and Practices in Early Childhood Education. A study of the practices and principles of using play as an educational tool in early childhood education; presents a review of historical, philosophical and psychological foundations of nursery-kindergarten methods, assesses techniques relating play to various aspects of instruction, surveys materials and equipment, and presents methods of classroom evaluation. ½ or 1 unit. Prerequisite: Elementary Education 237. KATZ, SPODEK.

335. Science in the Elementary School. The principles, place, and practice of science education in the elementary school and in the lives of children. The course stresses the functional nature of science and its place in the curriculum. Consideration is given to the organization of the science program, experiences, and techniques of value in teaching and of the role of the classroom teacher and the specialist. Opportunity for experience in field and laboratory work. ½ unit. Prerequisite: Elementary Education 237 or equivalent; two years of college science. ATKIN, R. W. BURNETT, SHORESMAN.

336. Primary Reading. Basic principles techniques, and materials for the developmental reading program in the primary grades. Emphasis is placed on methods and materials which provide for differentiated instruction. ½ or 1 unit. Prerequisite: Junior standing;

registration in a teacher education curriculum. DURKIN, KOENKE, MOORE, POWELL, SHORES.

337. Art Education in the Elementary School. Methods, plans, and materials for teaching art as an integral part of the total educational program in the elementary school. ½ unit. Prerequisite: Junior standing. LANSING, MARSHALL, SCHULTZ.

338. Teaching of Reading in Grades Four Through Twelve. Same as Secondary and Continuing Education 338. Developmental reading programs beyond the primary grades. Factors related to reading speed and comprehension; vocabulary development, specific comprehension skills, study skills, reading interests and tastes. ½ or 1 unit. Prerequisite: Elementary Education 336 or Educational Psychology 211. ERICKSON, KOENKE, POWELL, WALKER.

339. Corrective Reading. Same as Educational Psychology 339. Practice in administering and interpreting group diagnostic reading tests; instructional techniques appropriate for less severe reading disabilities. 1 unit. Prerequisite: Elementary Education 336 or 338. KOENKE, POWELL.

354. Audio-Visual Communication. Same as Secondary and Continuing Education and Library Science 354. An analysis and application of those introductory aspects of communication theory and practices concerned with the design and use of audio-visual messages which influence the learning process. This course is also concerned with selection, utilization, production, and evaluation of audio-visual materials and selected technological aids. ½ or 1 unit. Prerequisite: Senior or graduate standing. ISAACS.

Higher Education

COURSES FOR GRADUATES

442. The Junior College. Same as Vocational and Technical Education 442. The place of the junior college in the modern program of public education; social, economic, and other changes responsible for development of post-secondary education as found in junior colleges, area vocational schools, and technical institutes. 1 unit.

443. The College Student. Study of the characteristics and development of college students, the institutional contexts in which they operate, and the interaction of students with the college environment. 1 unit.

467. The American College and University. Introduction to higher education as a subject—its history, purposes, leaders, literature. Special attention to conceptual framework in which the further development of this subject can progress. 1 unit.

477. Student Personnel Work in Higher Education. Study of the theoretical foundations and principles underlying the practice of student personnel work. The role and function of student personnel workers are investigated in terms of their relationship to various goals, philosophies, issues, trends, research. 1 unit.

478. The Administration of Student Personnel Work. Structural arrangements for meeting student-oriented needs in the American college (including the junior college) and university. Special attention to the role of the chief administrative officer for student affairs. 1 unit. Prerequisite: Higher Education 477 or equivalent.

479. Organization and Control of Higher Education. Organizational patterns whereby colleges and universities seek to accomplish their purposes. Agencies involved in the control of higher education. 1 unit. Prerequisite: Higher Education 442, 467, or equivalent.

480. Internship in the Administration of Higher Education. Designed to provide supervised direct experience in the administration of higher education. Students, with the aid of the faculty in higher education, select the institution and position most relevant to their career goals. No more than two units may be offered toward an advanced degree. 1 unit. Prerequisite: Consent of instructor.

History and Philosophy of Education

COURSES FOR GRADUATES

400. Problems of Educational Theory. Analysis of the kinds of problems encountered in constructing an educational theory, and of relations between educational theory and other disciplines, especially philosophy and the social sciences. 1 unit. Prerequisite: History and Philosophy of Education 301 or 305. McMurray.

401. Modern Theories of Education. A critical analysis and examination of the theories of education represented by the work of Robert M. Hutchins, Henry C. Morrison, the Harvard Committee, and William H. Kilpatrick. 1 unit. Stanley.

402. Educational Movements in the Twentieth Century. An historical study of significant educational trends during the past sixty years, with special reference to their influence on American education; an analytical examination of the principal transition movements in the last decade of the nineteenth century and of efforts to solve the problems since 1900. 1 unit. Prerequisite: Consent of instructor. Karier, Violas.

403. The Historial Foundations of American Educational Thought. A study of the evolution of educational theories and philosophies since the eighteenth century, with particular reference to their impact upon educational developments in the United States. Effort is made to give a broad view of the general growth of American educational thought, with sufficient time devoted to selected major educational theorists, or schools of thought, to permit adequate exploration of their fundamental ideas and the relation of these ideas to significant intellectual currents in American culture. 1 unit. Prerequisite: Consent of instructor. Karier, Violas.

404. Seminar in Educational Classics. Reading and group discussion of a limited number of the most important writings in educational philosophy which have had a profound influence on the progress of educational thought and practice. 1 unit. Prerequisite: One graduate course in philosophy of education and one in history of education, or consent of instructor. Broudy.

405. Foundations of Aesthetic Education. A philosophical approach to the problems of teaching for appreciation in formal education. Appraisal of the status of aesthetic education, its nature and function, and its relation to other types of education are the major areas investigated. 1 unit. Prerequisite: History and Philosophy of Education 306 or consent of instructor. Broudy.

406. Seminar in the History of Education. Intensive group study of a small number of selected problems to assist individual students to develop an understanding of and the ability to use the techniques of historical research in furthering such study. Problems studied in any one semester are selected in the light of the interests and previous training of the group of students enrolled. Offered in 1971-1972 and in alternate years. 1 unit. Prerequisite: Two courses in the history of education and one course in the philosophy of education, or consent of instructor. Karier, Violas.

407. Logical Foundations of Methods. A study of the application of principles of logic in methods of instruction. This study involves the treatment of the problems of educational direction and control in processes of inference, judgment, and knowing, examined from the standpoint of recent developments in pragmatism. 1 unit. Prerequisite: Consent of instructor. McMurray.

408. Advanced Philosophy of Education. A systematic exploration of knowledge and inquiry as they relate to problems of formulating educational policy, curriculum design, organization of the school system, and teaching-learning. Selected materials in the history of epistemology are examined and emphasis is placed on a critical appraisal of significant trends in educational theory. 1 unit. Prerequisite: History and Philosophy of Education 301 or 305 or advanced graduate standing; consent of instructor. Broudy, J. R. Burnett, Stanley.

409. Advanced Philosophy of Education. A study of the nature of value as it relates to problems of formulating and justifying educational aims and policies, curriculum design, organization of the school system, and teaching-learning. Selected materials in ethics, value theory, and aesthetics are used in the critical appraisal of significant trends in educational theory. 1 unit. Prerequisite: History and Philosophy of Education 301 or 305 or advanced graduate standing; consent of instructor. BROUDY, J. R. BURNETT, STANLEY.

410. Seminar in Theories of Educational and Social Change. Designed to help prospective educational leaders acquire an understanding of current theories of social change as these relate to the work of the profession of teaching. There is now an extensive body of knowledge on the nature and control of social change. This needs to be made available to all prospective educational leaders in order that they may go about their duties with greater understanding and skill. Designed to aid students in bringing this knowledge to bear upon the problems of leadership in educational and social change. 1 unit. Prerequisite: Candidacy for Ed.D. or Ph.D. in education. BROUDY, J. R. BURNETT, FEINBERG, STANLEY.

449. Independent Study. To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by consent of the Dean of the College of Education. Prerequisite: Approval of study outline by adviser and the department chairman prior to enrollment.

483. Methods in Comparative Education. Methodologies and concepts involved in comparative educational systems in selected countries; topics related to the role of normative, institutional, and environmental patterns in shaping educational policies related to administration, curriculum development, diversification and expansion of educational opportunity. 1 unit. Prerequisite: Anthropology 373 or Sociology 300, History and Philosophy of Education 303 or 386, or consent of instructor. PESHKIN, YATES.

484. Education in the Industrialized Nations. An examination of education and national policy in industrialized nations. Topics include education and political integration, socialization, economic growth and manpower development, social status and mobility, and educational planning. Particular attention is given Western Europe, the U.S.S.R., and North America. 1 unit. Prerequisite: History and Philosophy of Education 303 or 386, or consent of instructor. YATES.

485. Education in the Developing Countries. An analysis of the role and functions of education in social, political, and economic development, with particular reference to the new and the developing countries. 1 unit. Prerequisite: History and Philosophy of Education 303 or 386, or consent of instructor. PESHKIN, YATES.

490. Seminar for Advanced Students of Education. Seminar in history and philosophy of education open only to persons who have been admitted for doctoral study in history and philosophy of education. Sections are usually offered in the following fields: (a) history of education, (b) philosophy of education, (c) comparative education, (d) social foundations of education. 1 to 2 units. No more than one unit per section may be counted toward a degree in any one semester. Prerequisite: For section (c) only, History and Philosophy of Education 483 or consent of instructor. STAFF.

491. Field Study and Thesis Seminar. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze crtically all presentations. Limited to students who have been admitted for doctoral study. 1 to 2 units. STAFF.

499. Thesis Research. Individual direction of research and these writing. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. The History of Education. Brief introductory survey of ancient and medieval education followed by a more extended study of educational developments since the Italian Renaissance. Special emphasis on the relation of educational trends to broader social, economic, political, and intellectual movements. ½ unit. KARIER.

301. Philosophy of Education. Based on Dewey's *Democracy and Education*, this course is an examination of experimentalist philosophy in its bearings on educational problems; nature and aims of education in a democratic society; relation of the individual to society; interest and discipline; play and work; freedom and control; subject matter and method. ½ unit. J. R. BURNETT, MCMURRAY, STANLEY.

302. History of American Education. The development of American education in relation to political, social, and cultural developments. Special attention is given to the influence of movements in the cultural environment upon evolving conceptions of educational theory and practice. ½ unit. TYACK.

303. Comparative Education. A study of selected national systems of education in their differing cultural settings. ½ unit. PESHKIN, YATES.

304. Social Foundations of Education. An introductory survey of the interrelationship between school and society and of the impact on public education of the major social trends and forces operating in our society. ½ unit. J. R. BURNETT, DIEKMA, FEINBERG, STANLEY.

305. History of Educational Ideas. Through a study of selected educational theorists and intellectual movements, this course provides familiarity with the major educational ideas of the past, as well as historical perspectives on current issues and problems in education. Readings in Plato, Quintilian, St. Augustine, Loyola, Comenius, Rousseau, Pestalozzi, Froebel, Herbart, Dewey, and others. ½ unit. FEINBERG, KARIER, MCMURRAY, VIOLAS.

306. Introduction to Aesthetic Education. A philosophic introduction to the problems of teaching for critical judgment and appreciation. Materials from aesthetics, art history, and criticism are examined for their relevance to the problems of aims, curriculum, organization, and teaching-learning, with special attention to problems of interrelated arts and humanities programs. Designed for prospective teachers of art, music, literature, and related subjects. ½ or 1 unit. R. A. SMITH.

315. Sociology of Education. Same as Sociology 315. Objective comparative study of education as a social process in various cultures and historical periods, with main emphasis on present education in countries which share Western civilization. ½ or 1 unit. Prerequisite: Sociology 100, or 104 and 105, or 151 and 152.

385. The Anthropology of Education. Same as Anthropology 385. Introduction to the contribution of anthropology to the cross-cultural study of education; includes illustrative material from representative cultures ranging from primitive social groups to present-day national states; emphasis is on education as a cultural process in relation to culture change and cultural development. ½ to 1 unit. Prerequisite: A course in anthropology or sociology, or consent of instructor. J. H. BURNETT.

386. Education and International Relations. An analysis of the role of education in international relations. Emphasizes the policies and programs of the major aid-giving nations, the competition among these nations, and the results of foreign assistance programs in the developing countries. ½ to 1 unit. Prerequisite: History and Philosophy of Education 303 or consent of instructor. PESHKIN.

Secondary and Continuing Education

COURSES FOR GRADUATES

439. Fundamentals of Curriculum Development. Designed to explore and clarify the several theoretical bases offered in educational literature for each of the major aspects of curriculum planning, to indicate the forms implementation of these theories have

assumed in practice, to reduce these theoretical and practical differences to fundamental issues, to encourage critical evaluation of both the theories and practices from the standpoint of logical and empirical evidence, and to project, on the basis of such analysis, needed research, present best practice, and ultimately desirable programs. 1 unit. STAFF.

441. Linguistic and Logical Analysis of Teaching. An analysis of teaching from the standpoint of semantic and logical factors. Topics such as theories of meaning, definition, explanation, and justification as employed by a teacher are discussed. 1 unit. K. B. HENDERSON.

448. Continuing Education. Development, status, and prospects of continuing education for adults. Institutions, agencies, and programs; public policy and policy-making for continuing education; organization, administration, finance, and promotion; recruiting, training, and supervising staff; planning programs and courses; the literature of continuing education. Systematic study of individual problems supplements class work. ½ or 1 unit. PHIPPS.

449. Independent Study. To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered two an advanced degree except by consent of the Dean of the College of Education. Prerequisite: Approval of study outline by adviser and the department chairman prior to enrollment.

456. Problems and Trends in Specialized Fields of Secondary Education. This course introduces the student to significant problems, points of view, and trends in the field concerned. Significant research relating to organization, content, and techniques in the field in question is explored. Students are encouraged to make special studies in approved areas. 1 unit. Sections are usually offered in the following fields:

(a) Language and Composition. FILLION, WALKER.
(b) Literature. FILLION, MADSEN.
(c) Foreign Languages. DAIGH, KAULFERS, KETTELKAMP.
(d) Mathematics. K. B. HENDERSON, PINGRY, TRAVERS.
(e) Science. R. W. BURNETT, GOULD, WELLER.
(f) Social Science. COX, METCALF.
(g) Physical Education. KNAPP.
(h) Music. COLWELL.
(i) Art. HARDIMAN.

459. Workshop in Curriculum Development. Curriculum development projects in specialized fields of secondary and continuing education. ½ to 2 units. STAFF.

490. Seminar for Advanced Students of Education. Open only to persons who have been admitted for doctoral study in secondary and continuing education. Sections are usually offered in the following fields: (a) English, (b) foreign languages, (c) mathematics, (d) science, (e) social studies, (f) music, and (g) higher education. 0 to 1 unit; may be repeated for a maximum of two units. STAFF.

491. Field Study and Thesis Seminar. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to students who have been admitted for doctoral study. 1 to 2 units. STAFF.

499. Thesis Research. Individual direction of research and thesis writing. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

338. Teaching of Reading in Grades Four Through Twelve. Same as Elementary Education 338. Developmental reading programs beyound the primary grades. Factors related to reading speed and comprehension; vocabulary development, specific com-

prehension skills, study skills, reading interests and tastes. ½ or 1 unit. Prerequisite: Elementary Education 336 or Educational Psychology 211. Erickson, Walker.

354. Audio-Visual Communication. Same as Elementary Education and Library Science 354. An analysis and application of those introductory aspects of communication theory and practices concerned with the design and use of audio-visual messages which influence the learning process. This course is also concerned with selection, utilization, production, and evaluation of audio-visual materials and selected technological aids. ½ or 1 unit. Prerequisite: Senior or graduate standing. Lorenz.

356. The Computer and Mathematics Education. Surveys the role of the computer as an educational tool with an emphasis on applications for teaching precollege mathematics. Analysis of computational problems and development of algorithms for their solution; iteration, nonlinear interpolation, and Monte Carlo methods; computer-assisted instruction; individually prescribed instruction; modular scheduling; information retrieval; library programs; natural language analysis. 1 unit. Prerequisite: Computer Science 101, 400, or consent of instructor. Travers.

Special Education

COURSES FOR GRADUATES

416. Problems in Mental Deficiency. An advanced course in mental deficiency, covering definitions, theories, classifications, etiology, diagnosis, and social, medical, psychological, and educational rehabilitation procedures. Emphasis is on the contributions of biology, sociology, anthropology, and psychology to educational theory and practice with reference to the mentally deficient. 1 unit. Prerequisite: Special Education 322 or consent of instructor. Salvia.

417. Psycho-Educational Problems of Exceptional Children. A course for educators, students in the behavioral sciences, and students beginning graduate study in special education. Study of relevant research dealing with the physical, mental, emotional, and social traits of all types of exceptional children and consideration of major current problems in the development of educational programs. 1 unit. Prerequisite: Sixteen hours of psychology and/or education or consent of instructor. Jordan.

418. Communicative Problems of the Deaf. An advanced course in the problems and procedures involved in the acquisition of language and communication by persons with severe hearing impairment, particularly those with profound prelingual deafness. Emphasis is placed on research and measurement in the development of speech, speechreading, residual hearing, reading, written language, and manual communication, including finger spelling and the language of signs. The applications of recent approaches in linguistics and psycholinguistics to language development are stressed. 1 unit. Prerequisite: Consent of instructor. Quigley.

419. Diagnosis of Learning Disabilities. A course covering the advanced theory and technology of learning disabilities with special reference to etiology and diagnosis. The main emphasis is on the psychoneurological, genetic, and psycholinguistic aspects of reading disorders. Remediation which is implicit in diagnostic procedure is also covered. Laboratory practice is required. This is the first half of a year's sequence with Special Education 444. 1 unit. Prerequisite: Special Education 318 (b); Psychology 443 or Educational Psychology 343; consent of instructor. Chalfant.

420. The Social Psychology of the Handicapped. A study of the social and emotional adjustment of handicapped children and adults, and of the somato-psychological significance of mental, sensory, and motor variations in the adjustive process. The effects of limitations imposed by the attitude of society, the attitude of the individual toward his handicap, and the handicap itself are evaluated. Implications for current educational programs for the handicapped are analyzed. 1 unit. Prerequisite: Special Education 117 or 417 and Educational Psychology 312, or consent of instructor. Newland.

421. Administration and Supervision of Special Education. Designed for advanced graduate students preparing for administrative or supervisory positions in special education programs. Administrative and supervisory practices in educating exceptional children are examined with emphasis on special education programs in the public schools; application of administrative theory to special education programs. Field trips to observe and evaluate programs are required. 1 unit. Prerequisite: Special Education 417; Educational Administration and Supervision 460; consent of instructor. CHALFANT, R. A. HENDERSON, M. B. KARNES.

444. Remediation of Learning Disabilities. The course covers the theory and practice of remediation of children with learning disabilities, with emphasis on matching a wide variety of methods to specific deficits. Advanced diagnostic procedures and teaching, prescription writing, and evaluative monitoring are covered. The course includes supervised clinical practice. 1 unit. Prerequisite: Special Education 318 (b) and 419. CHALFANT.

449. Independent Study. To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by consent of the Dean of the College of Education. Prerequisite: Approval of study outline by adviser and the department chairman prior to enrollment.

456. Problems and Trends in Special Education. Introduces the student to significant problems, points of view, and trends in the field concerned. Significant research related to organization, content, and techniques in the field in question is explored. Students are encouraged to make special studies in approved areas. Sections may be offered in the following fields: (a) mental retardation, (b) learning disabilities, (c) gifted children, (d) deaf children, (e) emotionally disturbed children, (f) programmed learning for exceptional children, (g) culturally disadvantaged children, and (h) administration. 1 to 2 units. Prerequisite: Consent of instructor. STAFF.

459. Workshop in Curriculum Development. Curriculum development projects in specialized fields of special education. Sections may be offered in the following fields: (a) mental retardation, (b) learning disabilities, (c) gift children, (d) deaf children, (e) emotionally disturbed children, (f) programmed learning for exceptional children, (g) culturally disadvantaged children, and (s) pre-school. 1 to 2 units. STAFF.

490. Seminar for Advanced Students of Education. Seminar in the education of exceptional children open only to persons who have been admitted for doctoral study. Sections may be offered in the following fields: (a) mental retardation, (b) learning disabilities. (c) gifted children, (d) deaf children, (e) emotionally disturbed children, (f) programmed learning for exceptional children, (g) culturally disadvantaged children, (h) administration, (u) behavior modification, and (x) special education. 1 to 2 units. STAFF.

491. Field Study and Thesis Seminar. The purpose of the seminar is to assist doctoral candidates in planning field studies and thesis problems. Each student is expected to present his study at each of four stages in its development: (1) the inception, delimitation, tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4) the final design stage. Students are expected to analyze critically all presentations. Limited to students who have been admitted for doctoral study. 1 to 2 units. STAFF.

499. Thesis Research. Individual direction of research and thesis writing. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

316. The Gifted Child in School and Society. A consideration of the gifted in society: who they are, their physical, psychological, social, and educational characteristics, and society's needs and provisions for them. The major portion of the course is devoted to the

consideration and evaluation of instructional and administrative adjustments th should be made for the gifted in the educational structure. ½ to 1 unit. Prerequisit Educational Psychology 211 or 236; consent of instructor. STAFF.

317. Psycho-Social Educational Aspects of Deafness. Historical and current societ perceptions of the deaf; analysis of the various effects and patterns of auditory impai ment on children and adults; intelligence, personal and social adjustment, the psych logical processes, and how they affect the acquisition of language, speech, speechreadin reading, and writing. ½ to 1 unit. Prerequisite: Special Education 117 and Psycholog 100 or Educational Psychology 211. QUIGLEY.

318. Workshop and Laboratory in Education of Exceptional Children. For tho specializing in exceptional children. The following sections may be offered: (a) ment retardation, (b) learning disabilities, (c) gifted children, (d) deaf children, (e) em tionally disturbed children, (f) programmed learning for exceptional children, (g culturally disadvantaged. 1 to 2 units. Prerequisite: Consent of instructor. STAFF.

319. Special Education of the Deaf, I. Survey of the curriculum and techniques in pr schools, kindergarten, primary, and intermediate levels as applied to the hard-o hearing, deafened, and deaf child; study of sense training, lip reading, vocabulary d velopment, reading techniques, elementary school subjects, language and speech d velopment, auditory training, and curriculum construction. 1 to 1½ units. Prerequisit Consent of instructor. STAFF.

320. Special Education of the Deaf, II. Continuation of Special Education 319. 1 to 2 unit Prerequisite: Special Education 319. STAFF.

321. Education of Disturbed and Conduct-Problem Children. A study of the socia emotional, and learning characteristics of children who are disturbed or who exhib problems of conduct; methods of diagnosis and differentiation; educational enviro ments and teaching methods used for their remediation. ½ to 1 unit. Prerequisite: Speci Education 117 or equivalent; Educational Psychology 236 or equivalent. STAFF.

322. Psychology and Education of the Mentally Handicapped, I. A study of the socia emotional, physical, and learning characteristics and problems of mentally hand capped children; identification and diagnosis; available services and provisions; educa tional programs and curriculum of the school. ½ unit. Prerequisite: Consent of instructo CLARK, JORDAN.

323. Psychology and Education of the Mentally Handicapped, II. Technique methods, and materials for teaching mentally handicapped children; principles unde lying course of study, parent counseling, and use of records. ½ unit. Prerequisite: Seni standing in special education; consent of instructor. CLARK, JORDAN.

324. Mental and Educational Measurement of Exceptional Children. Designe primarily to develop an understanding of and ability to interpret the results of psych logical and educational tests. Practice is provided in test administration, with emphasis c diagnosis and problems encountered in testing children who are acoustically, orth pedically, visually, or mentally handicapped, or speech defective. ½ or 1 unit. Pr requisite: Special Education 117 or consent of instructor. STAFF.

Vocational and Technical Education

COURSES FOR GRADUATES

442. Junior College. Same as Higher Education 442. The place of the junior college in th modern program of public education; social, economic, and other changes responsib for development of post-secondary education as found in junior colleges, area vocation schools, and technical institutes. 1 unit. STAFF.

445. Investment in Human Resources. Same as Labor and Industrial Relations 44 Activities which influence future monetary and psychic income by improving th

resources in people. The investments covered include schooling, on-the-job training, medical care, migration, and the search for information on prices and incomes, with main emphasis on education. A last section covers educational planning. 1 unit. Prerequisite: An introductory course in economics and in quantitative methods. STAFF.

449. **Independent Study.** To offer opportunity and challenge of self-directive, independent study, i.e., to develop the individual's ability as an independent student; to enable the student to pursue needed study in a field in which appropriate courses are not being offered during a given semester. ½ or 1 unit. No more than two units may be offered toward an advanced degree except by consent of the Dean of the College of Education. Prerequisite: Approval of study outline by adviser and the department chairman prior to enrollment.

450. **Evaluation in Home Economics Education.** Theory and techniques of evaluation in home economics at different educational levels; analysis and refinement of instruments, interpretation of results for self-evaluation and guidance, and effective administration of programs. 1 unit. MATHER, SPITZE.

451. **Supervision in Home Economics Education.** The theory, principles, and techniques of pre-service and in-service training of teachers of home economics; organization, administration, evaluation, and possible future improvement of existing programs. Class visitation and other techniques practiced; supervisory materials prepared. 1 unit. MATHER.

453. **Problems in Home Economics Education.** Designed to prepare "consumers of research" through a comprehensive study and evaluation of home economics investigations now available and through the experience of carrying out an individual investigation of limited scope. 1 unit.

456. **Problems and Trends in Specialized Fields of Vocational and Technical Education.** This course introduces the student to significant problems, points of view, and trends in the field concerned. Significant research relating to organization, content, and techniques in the field in question is explored. Students are encouraged to make special studies in approved areas. Sections are usually offered in the following fields: (a) agricultural education, (b) business education, (c) home economics education, (d) industrial education. 1 unit. STAFF.

459. **Workshop in Curriculum Development.** Curriculum development projects in the specialized fields of agriculture, business, home economics, and industry. ½ to 2 units. STAFF.

471. **Policy and Program Development for Education in Agriculture.** Local, state, and national policies for agricultural education; organizing for policy-making; developing desirable policies and programs. ½ unit. Prerequisite: Vocational and Technical Education 276 and 277. Open to school administrators and extension educators without prerequisite. HEMP, PHIPPS.

472. **Course Planning and Teaching Procedures in Agricultural Occupations Programs.** Gathering data essential in course planning, constructing course plans, developing resource units, teaching procedures, and instructional aids. ½ unit. Prerequisite: Vocational and Technical Education 276 and 277, or consent of instructor. HEMP, WALKER.

473. **Vocational Education in Agriculture for Adults.** The case for adult education, needs of young and adult farmers for education, development and present status of adult education in agriculture, objectives, evaluation, using advisory committees, organizing adult classes, enrolling students, course planning, teaching procedures and aids, supervised practice, group activities, facilities. ½ unit. Prerequisite: Vocational and Technical Education 276 and 277, or consent of instructor. HEMP, PHIPPS.

474. **Supervised Agriculture Experience in Agricultural Occupations Programs.** Supervised agricultural experience programs as an educational strategy; importance and meaning of supervised agriculture experiences; planning, conducting, supervising,

and evaluating agriculture experience programs; relation of supervised agriculture ex perience programs to establishment and advancement in an occupation; keeping and using records; relating class instruction to supervised agriculture experience programs ½ unit. Prerequisite: Vocational and Technical Education 276 and 277, or consent o instructor. HEMP, PHIPPS.

475. Organizing and Teaching Agriculture Mechanics. Agriculture mechanics as a phase of vocational education in agriculture: purposes, course planning for high schoo students, young farmers, and adults; methods of teaching and evaluating on-farm or on job instruction; planning agriculture-mechanics shops and facilities; providing and teaching safety in agriculture mechanics. ½ unit. Prerequisite: Vocational and Technica Education 276 and 277, or consent of instructor. PHIPPS.

476. Guidance in Agricultural Education. The guidance function in young farmers adult classes, determining and preparing for agricultural opportunities, personnel in cluded in vocational classes, preparation of plans for teaching about agricultura occupations, tests and other aids in guidance, establishment, placement, follow-up ½ unit. Prerequisite: Vocational and Technical Education 276 and 277, or consent o instructor. HEMP, WALKER.

481. History and Basic Concepts of Vocational Education. A course in the historica development of modern vocational education, the educational theories underlying it development, and the educational concepts upon which present programs and pro cedures are based. 1 unit. CAMPBELL, TOMLINSON.

482. Research Studies in Vocational and Technical Education. Study and evaluatio of examples of research in this field; a consideration of the research needed to solv present problems. Each student proposes and completes a brief research project, c plans in detail a major research project to be completed later. 1 unit. BALDWIN, EVAN PHIPPS.

487. Seminar in Vocational, Technical, and Practical Arts Education. Overview an interpretation of social, economic, and technological trends which have relevance to th problem of developing new programs in the vocational, technical, and practical ar areas; analysis and evaluation of innovations in the field; current issues and problem 1 unit. Prerequisite: Graduate standing in vocational and technical education. EVAN PHIPPS, TOMLINSON.

488. Curriculum Problems and Trends in Industrial Education. Selection and organi zation of instructional materials for industrial courses; study of basic concepts under lying course construction in industrial education. 1 unit. Prerequisite: Undergraduat work in appropriate vocational and technical education courses. SREDL, STERN.

489. Administration and Supervision of Vocational and Technical Education. Prob lems and approved practices in the administration and supervision of programs of voca tional, technical, and practical arts education in secondary schools, junior colleges, and technical institutes. 1 unit. Prerequisite: Consent of instructor. EVANS, PHIPPS, TOM LINSON.

490. Seminar for Advanced Students of Education. Seminar in vocational and technica education open only to persons who have been admitted for doctoral study in vocationa and technical education. Sections of this seminar are usually offered in the followin areas: (a) industrial education, (b) agricultural education, and (c) home economic education. 1 to 2 units. STAFF.

491. Field Study and Thesis Seminar. The purpose of the seminar is to assist doctora candidates in planning field studies and thesis problems. Each student is expected t present his study at each of four stages in its development: (1) the inception, delimitation tentative design stage; (2) the proposed design stage; (3) the revised design stage; (4 the final design stage. Students are expected to analyze critically all presentations Limited to students who have been admitted for doctoral study. 1 to 2 units. STAFF.

499. Thesis Research. Individual direction of research and thesis writing. 0 to 4 units STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

349. Special Study and Investigation in Vocational and Technical Education. A course to offer opportunity for an individual to study, on or off campus, selected problems, trends, and new developments; or to conduct specialized technological investigations for the improvement of instructional programs in areas related to vocational and technical education. ½ to 1 unit. Prerequisite: Consent of instructor; demonstrated ability to pursue special study or investigation proposed. STAFF.

370. Agricultural Education for First-Year Teachers. Specific help with the problems of beginning teachers. Campus meeting in August. Other meetings in centers in the state convenient to first-year teachers. Visits by instructors to schools in which first-year teachers are employed. ½ unit. Prerequisite. Vocational and Technical Education 276 and 277. WALKER.

381. Principles of Vocational Education. Study of basic concepts and practices of modern vocational education. ½ or 1 unit. CAMPBELL, TOMLINSON.

382. Cooperative Vocational and Technical Education Programs. This course is designed to provide the specific professional background required of teachers, coordinators, and administrators who organize and conduct public school programs utilizing community resources and experiences. The course includes the background, philosophy, organization, and administration of cooperative education. ½ or 1 unit. MAHAFFEY, TOMLINSON.

383. Development, Organization, and Principles of Industrial Education. A survey of the problems and practices of the several phases of industrial education. ½ or 1 unit. SREDL, STERN.

384. The General Shop Program. A laboratory and theory course in the organization and administration of the industrial arts general shop program. 1 unit. Prerequisite: Sixteen hours in appropriate vocational and technical education courses. STERN, TINKHAM.

385. Problems in Concurrent Work-Education. While employed in approved cooperating business firms, students observe the relationships between their activities and the specialized educational programs in the high school and community college. In class sessions, emphasis is placed on job analysis, current trends, wage and benefit structure, personnel practices, labor relations and their implications for teaching. 1 unit. Prerequisite: Completion of prescribed courses in vocational and technical education for teaching in their area of specialization; consent of instructor.

387. Training Programs in Industry. A study of the organization, instruction, supervision, and evaluation of training programs conducted within industry, and their relationships to other educational agencies. 1 unit. BALDWIN.

388. Special Techniques of Teaching Vocational-Industrial Subjects. A study of the application of principles of industrial education in vocational-industrial education. Methods of developing industrial skills, appropriate vocational attitudes, and related technical knowledge are stressed. Lectures, discussions, and demonstrations. 1 unit. Prerequisite: Ten hours of undergraduate credit in appropriate vocational and technical education courses. CAMPBELL, STERN, TINKHAM

ELECTRICAL ENGINEERING

Graduate work in electrical engineering leading to the Master of Science and Doctor of Philosophy is offered to graduates of electrical engineering curricula substantially equivalent to that of the University of Illinois. Graduates of curricula in the physical sciences and mathematics may also be admitted to advanced study if they have the necessary background to profit from graduate work in electrical engineering. To be admitted, an applicant must have the equivalent of a grade-point average of 4.0 or B for the last sixty semester hours of undergraduate study. Courses for advanced undergraduates and graduates are also open for credit to qualified students majoring in other fields.

A minimum of eight units must be completed for the master's degree, including a thesis. At least four units must be at the 400 level, including a course in circuit theory and one in field theory. In addition, graduate or undergraduate credit in a modern physics course is required. Courses at the 300 level which are required in the undergraduate curriculum at Illinois can not be used as part of the eight units.

All students desiring to enter the doctoral program must take the electrical engineering qualifying examination. Students who earn the master's degree at the University of Illinois take the examination during the term they earn their eighth unit of graduate credit. Students who enter with the master's degree must take the examination during the first term here.

Eight units of course credit beyond the master's degree, or the equivalent, plus eight units of thesis research and a satisfactory thesis, are minimum requirements for the Doctor of Philosophy. The candidate also must have completed two courses in modern physics. In his course program he must offer a major and either one or two minors. A single minor requires four units in one field outside the major field, at least one of which must be at the 400 level. If two minors are chosen, each must consist of at least two units. Advanced courses in mathematics, physics, physiology, chemistry, nuclear engineering, and other branches of engineering are recommended minors.

Further details may be found in the *Electrical Engineering Graduate Study Manual*, available from the department.

FACULTY

Professors: E. C. Jordan (Head of Department), H. W. Ades, F. Adler, G. E. Anner, W. R. Ashby, D. S. Babb, A. D. Bailey, J. Bardeen, D. A. Bitzer, S. A. Bowhill, R. M. Brown, R. T. Chien, P. D. Coleman, J. B. Cruz, G. A. Deschamps, F. Dunn, J. D. Dyson, W. L. Emery, E. W. Ernst, G. H. Fett, O. L. Gaddy, L. Goldstein, P. Handler, D. F. Hang, M. S. Helm, C. D. Hendricks, Jr., F. E. Hohn, N. Holonyak, Jr., D. F. Holshouser, B. C. Kuo, Y. T. Lo, W. Mayeda, P. E. Mayes, M. S. McVay, W. E. Miller (Associate Head of Department), R. Mittra, D. E. Muller, S. Muroga, T. A. Murrell, G. R. Pierce, W. R. Perkins, D. Pines, W. J. Poppelbaum, J. E. Robertson, C. T. Sah, P. E. Schwarzlose, G. W. Swenson, Jr., J. T. Verdeyen, H. M. von Foerster, N. Wax, H. D. Webb, K. C. Yeh.

Associate Professors: D. P. Akitt, W. G. Albright, R. B. Ash, M. L. Babcock, R. W. Burtness, J. H. Cahn, B. E. Cherrington, D. H. Cooper, M. H. Crothers, P. R. Egbert, F. J. Fry, P. W. Klock, P. Kokotovic, P. E. Mast, E. A. Mechtly, G. A. Metze, N. Narayana Rao, J. P. Neal, F. P. Preparata, S. R. Ray, C. F. Sechrist, H. G. Slottow.

Assistant Professors: J. W. Beauchamp, J. M. Crowley, A. W. Dipert, A. H. Haddad, S. W. Lee, C. H. Liu, H. Merkelo, R. F. Pierret, B. G. Streetman, T. N. Trick, R. J. Turnbull.

COURSES FOR GRADUATES

400. Seminar. Required of all graduate students. No credit.

412. Advanced Engineering Measurements. Theory and practice of precision measurements of electric, magnetic, and physical quantities; factors influencing the choice of method. Comparative accuracy and practicability of measurement methods and limitation of technique; evaluation of errors; design and development of measurement apparatus and methods. 1 unit.

414. Engineering Applications of Linear Graphs. Same as Computer Science 414. Elementary theory of linear graphs. Euler graphs; incidence, cut-set and circuit matrices and their properties; realizability of cut-set, circuit and tree matrices; applications to network analysis and synthesis; signal flow graphs; applications to switching circuits and automata; communication networks. 1 unit. Prerequisite: Electrical Engineering 416; Mathematics 315 or 318.

415. Control System Theory and Design. Synthesis of feedback control systems to meet design specifications, including sensitivity; multivariable systems; introduction to systems with random inputs; state variable techniques; nonlinear systems. 1 unit. Prerequisite: Electrical Engineering 386 or equivalent, or consent of instructor.

416. Analysis of Networks and Systems. Dynamic equations of linear lumped networks and systems; time-domain analysis and state space methods; frequency-domain analysis and transform methods; stability criteria. Applications to various problems in electrical engineering. 1 unit. Prerequisite: Credit or registration in Mathematics 346 or 348; Electrical Engineering 322.

418. Electric and Magnetic Fields. Rigorous treatment of basic laws, static fields, typical field systems, harmonic functions, conjugate functions, conformal transformation. 1 unit.

420. Electromagnetic Waves and Radiating Systems. Fundamental electromagnetic theory with applications to transmission lines, waveguides, and antennas; introduction to the solution of advanced problems in static electric and magnetic fields. 1 unit. Prerequisite: Electrical Engineering 352.

421. Advanced Electromagnetic Engineering. Reciprocity and equivalence principles; formulation of scattering and diffraction problems; approximations for large and for short wavelengths; plane cylindrical, and spherical wave problems; variational methods; Wiener-Hopf techniques; applications to antennas and waveguide problems. 1 unit. Prerequisite: Electrical Engineering 420.

423. Gaseous Electronics and Plasmas. Irreversible thermodynamics; transport theory; magnetohydrodynamics; collective behavior. 1 unit. Prerequisite: Physics 362 and Electrical Engineering 420, or equivalent.

428. Analysis of Nonlinear Systems. Same as Theoretical and Applied Mechanics 428. Singular points and stability considerations are treated. Graphical and analytical methods, including the perturbation method, variation of parameters, Galerkin's method, and the Ritz method for solving nonlinear differential equations, are considered. 1 unit. Prerequisite: Mathematics 341; consent of instructor.

429. Active Networks and Feedback Systems. Active networks are analyzed in their linear small signal models. The following network functions are analyzed: driving point and transfer function, gain functions, feedback factors, gain sensitivity functions and network stability conditions. Computer calculation methods are applied to analysis and design problems. 1 unit.

431. Theory of Guided Waves. Propagation in general cylindrical waveguides; eigenvalue problems, stationary principles, microwave circuit theorems, boundary value problems, and the determination of circuit parameters; periodically loaded waveguides with anisotropic media. 1 unit. Prerequisite: Electrical Engineering 420.

432. Compound Semiconductors (Optical Devices). This course is concerned mainly with the properties of III-V and II-VI compound semiconductors and the devices which are unique to these materials. Major emphasis is placed in this course on materials such as GaAs, Ga(AsP), GaP, CdSe, Cd(SeS), etc., and in luminescence, semiconductor lamps and semiconductor lasers. 1 unit. Prerequisite: Graduate standing in electrical engineering with some background in modern physics, elementary quantum mechanics, and elementary semiconductor theory (or equivalent).

434. Random Processes and Linear Filtering. Basic concepts of random processes; spectral analysis; linear systems with random inputs. Applications of random processes in communications and control theory: parameter estimation and linear filtering. 1 unit. Prerequisite: Mathematics 361 or equivalent, or Electrical Engineering 359.

435. Theory of Semiconductors and Semiconductor Devices. Same as Physics 435. Introductory quantum mechanics of semiconductors; energy bands; dynamics of Bloch electrons in static and high frequency electric and magnetic fields: equilibrium statistics; transport theory, diffusion, drift and thermoelectric effects; characteristics of p-n junc-

tions, heterojunctions, and transistor devices. 1 unit. Prerequisite: Senior-level course in quantum mechanics or atomic physics.

437. Principles of Microwave Measurements. Generation and detection of the laboratory signal; the generalized impedance concept; matrix representation of waveguide discontinuities; determination of equivalent network parameters; analysis of measurement techniques by signal flow graphs; accuracy criteria. 1 unit. Prerequisite: Electrical Engineering 355 and 356.

438. Stochastic Processes in Engineering. Same as Aeronautical and Astronautical Engineering 453 and Theoretical and Applied Mechanics 418. Supplementing Aeronautical and Astronautical Engineering 453, Electrical Engineering 434, or Theoretical and Applied Mechanics 417 for additional engineering application of stochastic processes. Theories of random pulses and continuous Markov processes and their applications to dynamic and control systems; parametric excitations and stability; nonlinear devices; topics related to system failures. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 452, Electrical Engineering 434, Theoretical and Applied Mechanics 417, or equivalent.

439. Advanced Theory of Semiconductors and Semiconductor Devices. Continuation of Electrical Engineering and Physics 435. Selected advanced topics of current interest in the physics of semiconductors and solid state devices. 1 unit. Prerequisite: Electrical Engineering and Physics 435.

440. Advanced Power Circuit Analysis, I. Analysis of power systems by symmetrical and related components; equivalent circuits of lines, transformers, and machines; fault calculations on symmetrical and unsymmetrical power systems; the network analyzer in fault studies. 1 unit.

445. Power System Stability. Transient and steady-state stability in power systems; power flow equations; transient stability swing curves; critical clearing time; the network analyzer in stability studies; the analog computer in transient stability studies. 1 unit. Prerequisite: Electrical Engineering 440.

451. Advanced Network Synthesis. Active network synthesis; sensitivity of networks; scattering matrix, broad band matching, computer-aided design of filters and matching networks. 1 unit. Prerequisite: Electrical Engineering 324 or equivalent; credit or registration in Mathematics 346.

452. Time-Varying and Nonlinear Circuits. Energy considerations; equations in normal form; frequency power relations in nonlinear networks; frequency conversion; Lyapunov's direct method; the circle stability criterion; calculus of variations and Hamilton's principle applied to the stability and matching problems. 1 unit. Prerequisite: Electrical Engineering 416; Mathematics 346.

453. Optimum Control Systems. Formulation of the optimization problem; controllability; observability; stability, Lyapunov's second method; application of variational calculus, maximum principle and principle of optimality to control problems; stochastic control; adaptive control. 1 unit. Prerequisite: Electrical Engineering 415.

454. Sampled-Data Control Systems. Analysis and design of feedback control systems with digital and sampled data. 1 unit. Prerequisite: Electrical Engineering 386 or 415, or equivalent.

456. Coding Theory. Same as Computer Science 456. General discussion on coding theory with emphasis on the algebraic theory of cyclic codes; error-control procedures and circuits; applications to computers and data-transmission systems. 1 unit. Prerequisite: Mathematics 317 or equivalent, or consent of instructor.

463. Information Theory. Same as Computer Science and Mathematics 463. Mathematical models for information channels and sources; existence theorems for and construction of error-correcting codes. 1 unit. Prerequisite: Mathematics 361 or equivalent.

465. Topics in Automata Theory. Same as Computer Science and Mathematics 465. Topics selected from mathematical systems and automata theory, decision problems, formal languages, decomposition theory, etc. 1 unit. Prerequisite: Computer Science, Electrical Engineering, or Mathematics 392, or consent of instructor.

467. Atomic Collision Processes. Same as Physics 467. Elastic collisions of electrons with neutral atoms; inelastic electron-atom and electron-molecule collisions; collisions between heavy particles; molecule formation; photoprocesses and recombination; negative ions; collisions involving the emission of radiation; theory of spectral line-broadening in plasmas; experimental techniques. 1 unit. Prerequisite: Physics 480 or consent of instructor.

472. Quantum Electronics. A brief theoretical introduction to quantum mechanics and atomic physics, with many applications in spin resonance and modern maser theory. 1 unit. Prerequisite: Physics 381. It is recommended that Physics 362 and 385 be taken before registering in this course.

474. Problems of Cybernetics. Same as Biophysics and Communications 436. The study of brain-like processes in complex dynamic systems with emphasis on unsolved problems, current developments, and opportunities for research. 1 unit. Prerequisite: Consent of instructor.

475. Ionospheric Radio Propagation. Propagation in a stratified medium; WKB solution; ray theory; ionospheric sounding; ionospheric transmission problems; scattering by irregularities; propagation in a random medium; cross-modulation and nonlinear effects; magneto-ionic theory; Faraday effect; whistler propagation; coupling of characteristic waves; magneto-hydrodynamic waves; formation of ionospheric E-region; formation of F-region. 1 unit. Prerequisite: Electrical Engineering 420 or equivalent.

481. Threshold Logic. Same as Computer Science 481. Mathematical model of computer elements which work under threshold or majority principle; mathematical theory of threshold functions; realizability using a linear programming approach; network syntheses of majority principle devices. 1 unit. Prerequisite: Consent of instructor.

482. Theory of Digital Computer Arithmetic. Same as Computer Science 482. This course emphasizes the use of redundancy in the representation of digits in order to increase the efficiency of computer arithmetic. Topics include multiplier recoding, division with redundantly represented quotients, and structural redundancy as implied by carry-save and signed-digit techniques. 1 unit. Prerequisite: Computer Science or Electrical Engineering 394.

485. Advanced Theory of Magnetic and Optic Computer Memory Devices. Same as Computer Science 485. Theory of ferromagnetism and superconductivity applied to memory devices; light propagation in anisotropic media: modulators and deflectors; principles of laser operation. 1 unit. Prerequisite: Electrical Engineering or Computer Science 385.

486. Constitution of the Ionosphere: An Introduction to Aeronomy. Same as Astronomy 486. Properties of the neutral and ionized atmosphere above 60 km. height, and the photochemical processes causing them; diffusion of ionospheric constituents; solar and meteoric perturbations of the ions of the ionosphere. 1 unit. Prerequisite: Graduate standing in electrical engineering, physics, or astronomy; Mathematics 341 or equivalent.

490. Seminar in Special Topics. Lectures and discussions on current research and literature on advanced topics in electrical engineering. Course may be repeated. 0 to $\frac{1}{2}$ unit. Prerequisite: Advanced standing; consent of instructor.

497. Electrical Engineering Problems. Lectures and discussions relating to new areas of interest. 0 to 1 unit. Course may be repeated. Prerequisite: Consent of instructor.

498. Individual Study. Individual projects. $\frac{1}{2}$ to 2 units. Prerequisite: Consent of instructor.

499. Thesis Research. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

310. Systems, I. Fourier transform; matrix algebra; formulation of the normal-form equations in terms of the state variables; solution of the normal-form equation; convolution; stability of systems. 0 to $\frac{3}{4}$ unit. Prerequisite: Electrical Engineering 262.

323. Circuit Laboratory. To accompany Electrical Engineering 322 and 350. 0 or $\frac{1}{4}$ unit. Prerequisite: Electrical Engineering 251 and 262; credit or registration in Electrical Engineering 350.

324. Introduction to Network Synthesis. An introduction to modern methods of network synthesis; properties of driving-point and transfer functions; approximation and scaling; LC, RC, and RLC synthesis methods; ladder network development; and resistively terminated coupling networks. 0 to 1 unit. Prerequisite: Credit or registration in Electrical Engineering 310.

330. Magnetic Circuits and Transformers. Magnetic circuit analysis; transformer theory; special magnetic circuit applications. 0 to $\frac{3}{4}$ unit. Prerequisite: Electrical Engineering 229 and 262.

331. Magnetic Circuits and Transformers Laboratory. To accompany Electrical Engineering 330. 0 or $\frac{1}{4}$ unit. Prerequisite: Electrical Engineering 251; credit or registration in Electrical Engineering 330.

332. Electrical Machinery. Induction machines; single-phase motors; direct-current machines; application. 0 to $\frac{3}{4}$ unit. Prerequisite: Electrical Engineering 330 and 331; credit or registration in Electrical Engineering 333.

333. Electrical Machinery Laboratory. To accompany Electrical Engineering 332. 0 or $\frac{1}{4}$ unit. Prerequisite: Credit or registration in Electrical Engineering 332.

336. Advanced Analysis of Electric Power Equipment. Transformers, synchronous and induction machines; power machines in systems; single phase motors; extension of the two-reaction analysis to the general machine. 0 or 1 unit. Prerequisite: Electrical Engineering 330 and 331.

340. Electronics, I. Semiconductor materials and their electronic properties and applications to electronic devices; p-n junctions, transistors, and other diode and triode devices; low-frequency applications of diodes. 0 to $\frac{3}{4}$ unit. Prerequisite: Physics 108; Electrical Engineering 260.

341. Electronics Experimentation. Problems of experimentation and measurement with electronic circuits and devices. Lecture and laboratory. 0 or $\frac{1}{4}$ unit. Prerequisite: Electrical Engineering 251; credit or registration in Electrical Engineering 340.

342. Advanced Electronics. Linear and nonlinear amplification; modulation and demodulation concepts; introduction to feedback amplifiers and oscillators. 0 to $\frac{3}{4}$ unit. Prerequisite: Electrical Engineering 262, 340, and 341.

343. Electronics Laboratory. 0 or $\frac{1}{4}$ unit. Prerequisite: Credit or registration in Electrical Engineering 342.

344. Theory and Fabrication of Solid State Devices. A laboratory and lecture course on the physical theory, design, and fabrication of solid state devices which includes the electronic properties of semiconductors (such as mobility, carrier concentration, lifetime, energy gap) and techniques for fabricating (oxdiation, diffusion, oxide masking, alloying) p-n junction devices. 1 unit. Prerequisite: Electrical Engineering 340.

347. Industrial Electronics. Electronic circuits for automatic control and measurement systems with applications. Credit toward graduation is not given for both Electrical Engineering 347 and 381. 0 to 1 unit. Prerequisite: Electrical Engineering 330 and 342.

349. Nonlinear Electronic Circuits. An introduction to the elementary solution of zero, first-, and second-order differentio-integral equations encountered in the study of electronic circuits. Circuits used as examples employ uni- and bipolar transistors, unijunctions, tubes, and other devices. Emphasis is given to nonlinear negative resistance

applications in switching applications and in oscillators of the relaxation and quasi-sinusoidal types. ¾ or 1 unit. Prerequisite: Credit or registration in Electrical Engineering 342.

350. Lines, Fields, and Waves. Transmission lines, field calculations, and wave propagation. ¾ unit. Prerequisite: Electrical Engineering 229 and 262.

352. Electromagnetic Fields. Uniform plane waves, wave guides, radiation and propagation of electromagnetic energy, radiating systems, and electrodynamics. ¾ unit. Prerequisite: Electrical Engineering 350.

353. Radio Circuits. Component behavior at communication frequencies, impedance transforming networks for single and multiple frequencies; low-level tuned and compensated amplifiers, broad band impedance matching; equalizers. 0 to 1 unit. Prerequisite: Electrical Engineering 341; credit or registration in Electrical Engineering 310.

355. Fields and Waves. Electromagnetic fields; wave guides; radiation and propagation of electromagnetic energy; radiating systems. 0 or ¾ unit. Prerequisite: Electrical Engineering 229 and 350, or consent of instructor.

356. Microwave Techniques. UHF and microwave sources and detectors; laboratory techniques for UHF and microwave frequencies. 0 or ¼ unit. Prerequisite: Credit or registration in Electrical Engineering 352 or 355.

357. Radio Astronomy. Same as Astronomy 357. Instrumental theory and observational techniques; radar and meteors; the moon and planets; solar radio waves; galactic and extragalactic radio astronomy. 1 unit. Prerequisite: Physics 108.

359. Introduction to Noise and Information Transmission. Signals and their spectra; methods of communication systems analysis; modulation by AM, FM, PAM, PPM; origin of noise, properties of noise, introduction to probability theory, system comparison using statistical approach. ¾ or 1 unit. Prerequisite: Electrical Engineering 310.

366. Aeronomy: Physics of Upper Atmosphere and Space. Same as Astronomy and Physics 366. Structure and composition of the Earth's upper atmosphere, solar radiation and its interaction with the upper atmosphere; the ionospheric layers; planetary atmospheres; airglow and aurora; interplanetary plasma; the magnetic field of the Earth and its interaction with the solar plasma; experimental techniques. 1 unit. Prerequisite: Physics 342, 321 and 381, or consent of instructor.

367. Active Networks. A study of active device models and their application to electrical network equation forms. Systems are expressed in terms of their network functions; the characteristics of feedback systems are examined in particular. Sensitivity and stability factors are examined. ¾ unit. Prerequisite: Electrical Engineering 342.

373. Engineering Acoustics. Same as Theoretical and Applied Mechanics 373. Development of the basic concepts needed for the understanding of mechanical and electrical acoustic systems: vibrating string; vibrating membrane; plane waves; spherical waves; vibrating piston; acoustical filters; loudspeakers and microphones; principle of reciprocity; the ear; architectural acoustics. ¾ or 1 unit. Prerequisite: Mathematics 345 or equivalent, or consent of instructor.

376. Symmetrical Component Analysis of Power Systems. Representation of power systems; symmetrical components, positive, negative, and zero sequence impedances of network components, sequence networks; unsymmetrical faults, unsymmetrical power systems, matrix algebra in symmetrical component analysis. 0 or 1 unit. Prerequisite: Electrical Engineering 350.

378. Electric Power Networks. Steady-state power network analysis; inductive coordination; transmission line capacitance and resistance; network synthesis; application of computers to power network problems. 0 or 1 unit. Prerequisite: Electrical Engineering 350; credit or registration in Electrical Engineering 332.

381. Pulse Techniques. An introduction to the response of electrical networks to non-sinusoidal inputs, the analysis of active circuits with large signals, and the circuits and

techniques used in pulse and digital equipment. Credit toward graduation is not given for both Electrical Engineering 381 and 347. 0 or 1 unit. Prerequisite: Electrical Engineering 342.

382. Transistor Circuits. This course is the same as Electrical Engineering 383 but has one three-hour laboratory added each week. 1 unit. Prerequisite: Electrical Engineering 340, 342, and 343, credit or registration in Electrical Engineering or Metallurgical Engineering 384, or consent of instructor.

383. Transistor Circuits. Junction transistors, diodes, and related semiconductor devices. Emphasis equally divided between device properties as related to semiconductor physics and circuit properties. Small signal theory of amplifiers and oscillators, large signal theory of power stages and switching circuits, negative resistance effects, high frequency limitations. $^3/_4$ unit. Prerequisite: Electrical Engineering 342, credit or registration in Electrical Engineering or Metallurgical Engineering 384, or consent of instructor.

384. Properties of Solids. Same as Metallurgical Engineering 384. Perfect and imperfect crystal lattices, electronic structure of solids, including basic theory, and applications to transport properties of metals and semiconductors, semiconductor diodes, dielectric and magnetic properties of solids. $^3/_4$ unit. Prerequisite: Physics 383.

385. Theory of Semiconductor Computer Devices. Same as Computer Science 385. Crystal conduction; large signal d-c and transient behavior of semiconductor devices; charge storage theory, phase plane diagrams, tolerance optimization, and noise theory; integrated circuits technology; masking, oxidizing, and etching; emphasis on device-theoretical background for computer logic design. $^3/_4$ or 1 unit. Prerequisite: Computer Science or Electrical Engineering 294, or consent of instructor.

386. Fundamentals of Servomechanisms. Fundamental knowledge required in the analysis of servomechanisms and automatic control devices. 0 or 1 unit. Prerequisite: Consent of instructor.

387. Introduction to Quantum Electronics for Electrical Engineers. Application of quantum mechanical concepts to electronics problems; for example: the generation and detection of coherent radiation, tunneling effects, and bulk oscillations in semiconductors. 1 unit. Prerequisite: Physics 383.

388. Electronic Analog Computers. Design of analog computer elements, problem preparation, and representative solutions of physical problems. 0 or 1 unit. Prerequisite: Electrical Engineering 340, 341, and Mathematics 345, or consent of instructor.

389. Communication Design. Over-all communication design problems; kinds of propagation; noise and interference; antenna temperature; transmitter power requirements; frequency selection; design of a portion of a receiver, transmitter, or antenna. 0 or $^3/_4$ unit. Prerequisite: Electrical Engineering 342 and 350.

391. Boolean Algebra and Switching Theory. Same as Computer Science and Mathematics 391. Boolean algebra with applications to sets, logic, electronic and relay combinational circuits; Karnaugh and Quine-McCluskey minimization procedures with applications; introduction to sequential circuits. $^1/_2$ or 1 unit. Prerequisite: Consent of instructor.

392. Introduction to Automata Theory. Same as Computer Science and Mathematics 392. Semigroups, partially ordered sets, and other algebraic systems; asynchronous machines; abstract synchronous machines and their properties; regular sets; decomposition theory. $^1/_2$ or 1 unit. Prerequisite: Computer Science, Electrical Engineering, or Mathematics 391, or consent of instructor.

393. Digital Computer Circuit Design. Same as Computer Science 393. Design of switching circuits and systems taking into account properties of currently available diodes, transistors, and related circuit elements; applications to slow-speed as well as high-speed computer circuits and data handling links; component tolerance, circuit reliability, and cost factors are considered. 1 unit. Prerequisite: Computer Science or Electrical Engineering 294 or 391; Electrical Engineering 342; or consent of instructor.

394. Logical Design of Automatic Digital Computer Circuits. Same as Computer Science 394. A course in the design of automatic digital computers. Major emphasis is on logical structure of components and the interrelations necessary for automatic operation. 1 unit. Prerequisite: Computer Science or Electrical Engineering 294, or consent of instructor.

397. Projects and Lectures in Quantum Electronics. Study of processes involving quantum mechanical energy transfers in energized media leading to various lasering devices and their applications. A series of lectures, supplementing the special projects, offers background information on spectroscopy, collisional energy transfer, laser pumping schemes, modulation at optical frequencies, holography, and other related topics. 0 to 1 unit. Prerequisite: Senior standing; consent of instructor; Electrical Engineering 387 recommended.

ENGLISH LANGUAGE AND LITERATURE

(Including American Literature and Rhetoric and Composition)

Students who wish to be considered for admission to graduate work in English must have attained a grade-point average of at least 4.0, and must present the equivalent of at least twenty hours of undergraduate work in English or American literature, although students with at least fourteen hours may be considered on an individual basis and granted probational entrance. This does not include required college work in rhetoric or composition.

Master of Arts in English. In addition to satisfying the general requirements of the Graduate College, candidates must fulfill a course distribution requirement (some work in each of six chronological areas), and must demonstrate proficiency in one language normally chosen from French, German, Latin, and Italian. Other languages may be substituted with permission of the Director of Graduate Studies where the substituted language has particular relevance to the student's professional interests.

Master of Arts in the Teaching of English. Candidates must earn at least four units in English, at least two of them in courses at the 400 level. They must also give evidence that they have taken the equivalent of at least two years of undergraduate work in French, German, Latin, Greek, Russian, or Spanish. They must deposit a term paper with the department.

Specific requirements are divided into two programs, the first for those who have the Bachelor of Arts in English and the teacher's certificate, and the second for those who have the Bachelor of Arts in English but not the teacher's certificate. See pages 36 and 37.

For those with the certificate, the requirements are English, four units, to be chosen in consultation with the adviser to fill gaps in preparation; education, two units, as follows: History and Philosophy of Education 304, 305, and Educational Psychology 311, 312; specialized courses for high school teachers of English, as follows: one unit of either Education 456 or English 447; three-quarters unit of either Linguistics 387 or English 370; electives as needed to total at least eight units.

For those without the certificate, the requirements are English, four units, to be chosen in consultation with the adviser to fill gaps in preparation; education, two units, as follows: History and Philosophy of Education 304, 305, and Educational Psychology 311, 312; specialized courses for high school teachers of English, as follows: one-half to three-quarters unit in either Linguistics 387 or English 370; electives, as needed to total at least eight units. In addition to these courses, candidates must take, without graduate credit, Secondary Education 241 (Technic of Teaching in the Secondary School) and Educational Practice 242 (Educational Practice in Secondary Education). This program is designed to permit most candidates to complete their work and qualify for both the certificate and the master's degree in two semesters and a summer. Those who lack certain prerequisites, such as general psychology, may need a little more time.

Master of Arts in the Teaching of English as a Second Language. The Master of Arts in the Teaching of English as a Second Language incorporates courses from two core areas: English and linguistics. The curriculum has two options. Students who later seek a

Ph.D. in one of the core areas may apply some courses from this curriculum toward a doctorate with approval of the department of their specialization.

Applicants for admission must satisfy general requirements of the Graduate College and must present appropriate academic preparation in one of the core areas, in secondary education in the teaching of English, or in elementary education. Applicants with majors in related areas, such as a foreign language, speech, or one of the social studies, are considered on an individual basis. Native speakers of English must have achieved proficiency in one foreign language that is equivalent to at least two years of undergraduate study. Non-native speakers of English must demonstrate acceptable proficiency in English.

Option 1. Candidates for the degree must earn a total of eight units, at least five of which are in the core areas and two in education. Candidates must pass the final comprehensive examination in the core areas and must deposit with the department one term paper or an essay on a topic related to the teaching and learning of English as a second language.

Option 2. The general requirements for the completion of the degree in Option 1 apply also to Option 2. However, the curriculum for Option 2, which may require eight to ten units, depending upon the student's preparation, includes a one-year internship teaching English in Puerto Rico. This internship is integrated with academic study under the direction of the University of Illinois faculty in the field and on campus. The candidate receives two units of credit based on his internship (one unit in English or Linguistics and one unit in the History and Philosophy of Education). One of the papers submitted for credit on the internship is to be deposited with the department.

Doctor of Philosophy in English. Students, in consultation with a committee of advisers, select eight units of graduate-level course work related to an area of concentration. This work may be done in seminars, in studies courses, or in independent study; the courses may be those offered in the Department of English or those of other departments. There are no formal requirements for further foreign-language work, philology-linguistics, or outside minors. Such work will be incorporated into the student's individually designed program as the professional demands of his field of concentration require.

There are four examinations: the proficiency examination (which students take in the first semester of their doctoral course work), the general examination (taken at or near the end of course work), the special field examination, and the final examination on the dissertation.

More detailed information may be obtained by requesting a mimeographed statement, "Graduate Studies in English," from the Director of Graduate Studies, Department of English, 100 English Building.

FACULTY

Professors: A. L. Altenbernd (Head of Department), Katharine O. Aston, A. E. Barker, L. E. Berry, J. J. Campbell, E. H. Davidson, J. T. Flanagan, R. H. Green, G. Hendrick, A. G. Holaday, J. N. Hook, B. A. Milligan, R. W. Rogers, C. H. Shattuck, D. A. Smalley, J. Stillinger, H. W. Wilson.

Associate Professors: Nina Baym, E. J. Brandabur, J. A. Dussinger, R. L. Fumento, F. E. Hodgins, U. M. Kaufmann, D. V. Kramer, R. J. Loftus, H. Marder, S. Millett, F. B. Moake, A. C. Purves, C. Sanders, R. L. Schneider, A. L. Scott, G. Scouffas, G. B. Stillwell, R. H. Wasson, B. F. Wilkie.

Assistant Professors: R. R. Allen, S. B. Bennett, M. D. Bristol, H. C. Cole, R. P. Fox, J. P. Frayne, Jan L. Hinely, J. R. Hurt, A. Kaufman, W. D. Kay, K. Kinnamon, D. Majdiak, O. Puravs, R. D. Rhodes, M. Shapiro, J. F. Stottlar, J. C. Stubbs, A. M. Tibbetts, J. B. Trahern, L. Waldoff, Emily S. Watts, D.E. Whisnant, G. G. Wright.

English Literature and American Literature

COURSES FOR GRADUATES

401. Old English: Anglo-Saxon. An introduction to the language before 1000 A.D. 1 unit.

402. Old English: Beowulf. 1 unit. Prerequisite: English 401.

403. History of the English Language. A study of the development of the language from the earliest stages to the present time. 1 unit.

404. Old English Literature and Its Cultural Background. An intensive, critical examination of Old English prose and poetry exclusive of Beowulf. The texts studied vary from year to year, but particular attention is given to such important bodies of writing as the Elegies, the *Anglo-Saxon Chronicle*, and the works of Cynewulf, Aelfric, Alfred, and Wulfstan. 1 unit. Prerequisite: English 401 and 402.

405. Middle English. Introduction to Middle English dialects, with special emphasis on the East Midland. Offered in 1970-1971 and in alternate years. 1 unit.

406. Middle English Literature and Its Cultural Background. English literature from 1100 to 1500 (excluding Chaucer), with emphasis on chronicle, romance, debate, lyric, and such major poems as *Pearl*, *Sir Gawain and the Green Knight*, and *Piers Plowman;* historical, social, and religious backgrounds. 1 unit.

407. Studies in Chaucer and His Times, I. A study of Chaucer and his contemporaries. The chief aim of this course is an intimate acquaintance with Chaucer's poetry and an appreciation of his art. 1 unit.

408. Studies in Chaucer and His Times, II. Continuation of English 407. 1 unit.

411. Studies in Sixteenth-Century Literature, I. 1 unit.

412. Studies in Sixteenth-Century Literature, II. Continuation of English 411. 1 unit.

413. Studies in Shakespeare. 1 unit.

414. Studies in Elizabethan Drama. 1 unit.

416. Studies in Late Renaissance Thought and Literary Theory. The development of cultural ideas—religious, social, educational—in representative prose writers of the late sixteenth century and of the seventeenth century (Hooker, Bacon, Burton, Browne, Milton, Dryden, and others) in relation to literary theory and practice. 1 unit.

417. Studies in Seventeenth-Century Poetry and Milton (1600 to 1640). 1 unit.

418. Studies in Seventeenth-Century Poetry and Milton (1640 to 1700). Continuation of English 417. 1 unit. Prerequisite: English 417.

421. Studies in Eighteenth-Century Literature, I. 1 unit.

422. Studies in Eighteenth-Century Literature, II. Continuation of English 421. 1 unit.

423. Studies in the Eighteenth-Century Novel. 1 unit.

427. Studies in the Romantic Movement, I. 1 unit.

428. Studies in the Romantic Movement, II. Continuation of English 427. 1 unit.

431. Studies in Victorian Literature, I. 1 unit.

432. Studies in Victorian Literature, II. Continuation of English 431. 1 unit.

433. Major Movements in Modern British Poetry and Drama. A study of important movements, figures, and ideas which shaped the criticism and practice of modern poetry. 1 unit.

434. Major Movements in Modern British Fiction. A study of important movements, figures, works, and ideas which shaped the criticism and practice of modern fiction. 1 unit.

437. Studies in American Literature: 1600 to 1800. Studies in the Puritan mind from Bradford through Jonathan Edwards and in the Englightenment, with Franklin, Jefferson, Paine, and the first literary artists as the bases of inquiry. Offered in 1971-1972 and in alternate years. 1 unit. Prerequisite: A survey course in American literature or consent of instructor.

438. Studies in American Literature After 1800. A course which investigates literary movements, major writers, and intellectual and cultural ideas in American literature

from 1800 to the present. The subject matter of the course varies each time it is offered. 1 unit. Prerequisite: A survey course in American literature or consent of instructor.

442. Studies in Recent Literary Theory. The analysis of representative critics and critical schools of the twentieth century; similarities and differences between them and older critics in the solutions proposed to the central problems of literary theory. 1 unit.

444. Studies in Modern Drama. An examination of twentieth-century playwrights and dramatic theorists who have contributed significant art and ideas to the modern drama. 1 unit.

445. Introduction to Advanced Graduate Study. A consideration of the methods and aims of literary scholarship. 1 unit.

446. Introduction to Advanced Graduate Study. A consideration of the methods and aims of literary criticism, and of the profession of college English teaching. 1 unit.

447. Background Materials for High School Teachers of English. Investigation of the content that is desirable in high school literature and composition. S; 1 unit.

448. Literary Analysis for Teachers of English. An examination of the theoretical considerations underlying various approaches to teaching literature at the high school and introductory college level. 1 unit. Prerequisite: Teaching experience at secondary or college levels.

450. Problems in Bibliographical Method. Same as Library Science 440. Work on individual bibliographical problems, with a study of bookmaking, manuscripts and their relation to the printed text, editorial problems, and literary forgeries. 1 unit. Prerequisite: Consent of instructor.

457. Problems in Medieval Literature. A conference and research course devoted to special problems, literary movements, and writers of the period. 1 unit.

458. Problems in Sixteenth-Century Literature. A conference and research course devoted to special problems, literary movements, and writers of the period. The subject matter of the course varies each time it is offered. 1 unit. Prerequisite: English 411, 412, or equivalent; or consent of instructor.

462. Problems in Tudor Drama. 1 unit.

463. Problems in Shakespeare. 1 unit.

464. Problems in Elizabethan Drama. 1 unit.

466. Problems in Seventeenth-Century Metaphysical Poetry and Prose. Literary technique in relation to intellectual and religious problems in the poetry and prose of John Donne, his contemporaries and successors. 1 unit. Prerequisite: English 345 or 417, or consent of instructor.

467. Problems in Milton and His Age. 1 unit. Prerequisite: English 342 or 418 or consent of instructor.

469. The Stage History of Classic English Plays. Same as Speech 469 and Theatre 469. Analysis and reconstruction of past productions of classic plays, with special reference to Shakespeare. 1 unit. Prerequisite: One year of work in dramatic literature or theatre history; consent of instructor.

471. Problems in Eighteenth-Century Literature. A conference and research course devoted to special problems, literary movements, and writers of the period. The subject matter of the course varies each time it is offered. 1 unit.

476. Problems in Romantic Literature. A conference and research course concerning special problems, literary movements, and writers of the English Romantic period. The subject matter of the course varies each time it is offered. 1 unit.

478. Problems in Prose Fiction. Offered in 1971-1972 and in alternate years. 1 unit. Prerequisite: Second-year graduate standing.

479. Problems in Victorian Literature. 1 unit. Prerequisite: English 431 or 432 or consent of instructor.

480. The English Novel in Transition, 1890 to 1914. An examination of the works of principal Edwardian novelists, chiefly John Galsworthy, Arnold Bennett, and H. G. Wells, in terms of the transition of the English novel from Victorian to modern. 1 unit.

484. Problems in Twentieth-Century English Literature. A conference and research course devoted to selected writers and critical movements of the period. 1 unit. Prerequisite: English 433 or consent of instructor.

486. Problems in American Criticism and American Culture. Papers and discussions on literary critics and historians who have used literature as an index to the problems of American culture, 1900 to 1959. 1 unit. Prerequisite: A survey of American literature or consent of instructor.

488. Problems in American Literature and Cultural History. 1 unit. This course may be repeated for a total of two units. Prerequisite: A survey of American literature or consent of instructor.

491. Research in Special Topics. Research in selected topics by arrangement with the instructor. 1 unit. This course may be repeated for a total of two units.

497. Independent Reading. A course in individual readings from the areas of literature as offered by the department at the advanced undergraduate-graduate level. May only be taken concurrently with a 300-level course. No student may offer more than a total of $\frac{1}{2}$ unit of English 497. Prerequisite: Consent of instructor of requisite 300-level course. $\frac{1}{4}$ unit.

499. Thesis Research. Guidance in writing theses for advanced degrees. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. Historical Introduction to the English Language. Relation of English to other languages; major phonological, morphological, syntactic, and lexical changes in English from the beginnings to the present. $\frac{3}{4}$ unit. Prerequisite: English 386.

310. Literature for the High School. An introduction to the guidance of high school readings in literature, including a survey of books of graduated difficulty through an individualized program of independent reading, an examination of reference tools and teaching materials in English, but with chief emphasis upon an intensive critical study of representative works. $\frac{3}{4}$ unit.

311. Chaucer. $\frac{3}{4}$ unit.

316. American Drama from 1900 to 1960. A survey of American dramatic literature of the twentieth century, including the reading of a large number of plays which illustrate the diversity and importance of modern American drama. Special attention is given to the work of Maxwell Anderson and Eugene O'Neill. $\frac{3}{4}$ unit.

325. English Literature from 1500 to 1660. Survey of English literature of the Renaissance, exclusive of Milton and the drama. $\frac{3}{4}$ unit.

326. Spenser and His Contemporaries. A study of the principal preoccupations and forms of Elizabethan poetry, with special reference to Spenser. $\frac{3}{4}$ unit. Prerequisite: Six hours of English literature.

336. English Drama Exclusive of Shakespeare. From 1600 to 1700. $\frac{3}{4}$ unit.

338. Tragedy. Comparative study of masterpieces in several periods of Western culture. Major emphasis on ancient Greek and Roman, and English Elizabethan and Stuart drama. $\frac{3}{4}$ unit.

339. Comedy. The history and theory of comic drama. $\frac{3}{4}$ unit.

340. Satire. Comparative study of the chief nondramatic satires of Western civilization, from Roman times to the present. Particular emphasis is given to the bearing these works and traditions have on English satire. Offered in 1970-1971 and in alternate years. $\frac{3}{4}$ unit.

342. The Poetry of Milton. Origins, forms, artistic and ethical values; Milton's place in English literary history. $\frac{3}{4}$ unit.

345. The Metaphysical Poets. Class reading and discussion of the poetry of the principal members of the group known as the Metaphysical Poets (Donne, Herbert, Vaughan, Crashaw), with special emphasis on the poetry of John Donne. 3/4.

346. The Age of Dryden. A study of Restoration literature, dramatic and non-dramatic, centered around Dryden. 3/4 unit.

348. Swift, Pope, and Fielding. A study of the principal ideas and methods of satire as revealed in the writing of the three major English satirists. Written reports and extensive readings. 3/4 unit. Prerequisite: A course in English literature.

349. Dr. Johnson and His Circle. The principal writings of Johnson, Boswell, Goldsmith, Reynolds, Burke, Gibbon, and Sheridan; the position of Johnson's circle in the social and literary life of the second half of the eighteenth century. 3/4 unit.

351. The Mid-Victorian Novel. Thackeray, Emily Brontë, Mrs. Gaskell, Dickens, George Eliot, Trollope. 3/4 unit.

352. American Literature: Irving to Whitman. A study of the major American writers from 1800 to the Civil War, with particular emphasis on Cooper, Poe, Emerson, Thoreau, Hawthorne, Melville, and Whitman. 3/4 unit.

354. Studies in Middle Western Literature, II. A survey of Middle Western literature from 1900 to the present, with special emphasis on the development of realism in poetry and fiction. Offered in 1970-1971 and in alternate years. 3/4 unit. Prerequisite: One course in American history or one of the following: English 255 or 256.

359. The International Folk Tale. Same as Comparative Literature 359. A study of the origin, distribution, and nature of the folk tale with special reference to themes and variants. Representative tales of various areas (Africa, Germany, Greece, India, Ireland, Japan, Norway) are analyzed, and North American Negro and Indian tales are discussed. 3/4 unit.

360. The Popular Ballad and the Folk Song in the United States. A study of the British and Scottish popular ballad—the Child ballad as it is familiarly known—as it developed in Great Britain and as it was transplanted to the United States, with special emphasis on the development of native American ballads and songs. 3/4 unit.

363. Advanced Dramatic Writing. Same as Speech 363, Radio and Television 363, and Theatre 380. Application of principles of dramatic form and structure to the more complex problems of playwriting. Practice in writing sustained dramatic forms. 1/2 or 1 unit; students may accumulate two units of credit. Prerequisite: Speech 263 or equivalent; consent of instructor.

370. Theory and Practice of Written Composition. History and theory of written composition; basic rhetorical principles; guidance and criticism of student writing. 3/4 unit.

371. History and Principles of Literary and Rhetorical Criticism: Aristotle to Sidney. Same as Speech 371. 1/2 or 1 unit.

372. History and Principles of Literary and Rhetorical Criticism: Sidney to the Present. Same as Speech 371. 1/2 or 1 unit.

375. Henry James and the Technique of Fiction. A study of the development of Henry James as a novelist, of influences upon him, and of his influence on novelists of the twentieth century, chiefly American. 3/4 unit.

376. American Criticism and American Culture. This course examines the basic problem of the relation of literature to the Republic as a continuing historical issue; the idea of a national literature, the function of the artist in a democracy, the content and range of American criticism. The analysis centers on the major American critics. 3/4 unit. Prerequisite: English 255 and 256.

377. Major American Poets. A study of Poe, Whitman, Dickinson, Frost, Eliot, and Cummings with emphasis upon critical interpretation of their writings and the kinds of literary form characteristic of them. 3/4 unit. Prerequisite: A course in English or American literature.

378. Modern American and British Fiction in Its European Background. A study of the interrelationship between certain themes and techniques in the development of the contemporary American, British, and European novel (from Dostoevsky, Melville, and Conrad through Mauriac, Dos Passos, Kafka, Gide, Faulkner, and Sartre to the present day). 3/4 unit. Prerequisite: Two college-level literature courses.

380. Mark Twain and the Rise of Realism. A study, with special emphasis upon Mark Twain, of the rise of realism in American fiction from 1850 to 1900. 3/4 unit. Prerequisite: English 256 or consent of instructor.

381. Themes and Movements in British Literature. An intensive study of a recurrent idea or of a literary situation. 3/4 unit. Prerequisite: Six hours of English or American literature.

382. The Plays of Bernard Shaw. 3/4 unit.

384. Comparative Studies in Twentieth-Century Poetry. A study of contemporary poetry in English in its relationship to modern European verse. The poets studied may vary each time the course is offered. 3/4 unit. Prerequisite: Three hours in either poetry or modern literature, or consent of instructor.

385. Themes and Movements in American Literature. An intensive study of a recurrent idea or of a literary situation. 3/4 unit.

386. Modern English Grammar and Usage. Traditional and contemporary grammars; principles of usage. 3/4 unit.

387. The Structure of English. Same as Linguistics 387. Critical evaluation of traditional and structuralist grammatical descriptions; introduction to transformational grammatical studies; detailed survey of a transformational syntax of English; brief introduction to generative phonology and morphophonemic analysis of English, especially stress. 3/4 unit.

392. Typographic Disciplines of the Book. Same as Journalism and Library Science 310. The study of the book as a manufactured object, with emphasis upon practices and methods in continuous use from the Renaissance to the present, including type faces, paper, binding, and illustration. Extensive practicum in the typographic laboratory. 1/2 unit. Prerequisite: Consent of instructor.

394. Introduction to Folklore: History, Theory, Methods. Same as Comparative Literature, German, and Slavic 394, and Speech 346. An introduction to the study of folklore with emphasis on folkcultures in the Old and New World; an historical survey of the development of folklore study, an analysis of the methods and genres of folklore, and an introduction to field collecting and evaluation of archival materials. 3/4 unit. Prerequisite: A reading knowledge of one modern foreign language is recommended.

Rhetoric and Composition

COURSES FOR GRADUATES

400. Verbal Communication in English as a Second Language for Graduate Foreign Students, I. A language laboratory course concentrating on the typical writing problems that a graduate or research student encounters in an American university. 4 semester hours. No graduate credit. Prerequisite: Rhetoric 111 or consent of instructor.

401. Verbal Communication in English as a Second Language for Graduate Foreign Students, II. A language laboratory course dealing with individual, immediate and specialized speaking and writing problems, with particular attention to orienting the graduate student to the techniques of the American university in thesis and other specialized writings and in the oral presentation of such material. 4 semester hours. No graduate credit. Prerequisite: Rhetoric 400 or consent of instructor.

419. Contrastive Linguistics. Same as Linguistics 419. A critical survey of contemporary

linguistic models with special reference to their relevance in preparing contrastive analyses of languages; detailed discussion on contrastive analyses of English and selected non-western languages at different linguistic levels. 1/2 or 1 unit. Prerequisite: Linguistics 300 or consent of instructor.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

330. The Writing of Poetry. The practice of the writing of poetry, aided by intensive study of examples. 3/4 unit. Prerequisite: Rhetoric 145, junior standing, and six hours of English literature, or consent of instructor.

379. American Language and Literature. A non-credit course to develop facility in the English language through a study of American literature and culture. This course is open to any foreign student who has completed Rhetoric 109, 110, and 111 or who was not required to take these courses. No credit.

388. Linguistics in Language Learning, I. Same as Linguistics 388. The application of linguistic analyses to the learning of a second language, with special emphasis on the learning of English. 3/4 unit. Prerequisite: Two years of a foreign language or equivalent; consent of instructor.

389. Linguistics in Language Learning, II. Same as Linguistics 389. Applied linguistics in teaching and learning English as a second language, with special emphasis on the application of some principles of psycholinguistics, sociolinguistics, and ethnolinguistics along with the related disciplines of education, psychology, and anthropology to structured teaching/learning situations. 3/4 unit. Prerequisite 388.

ENTOMOLOGY

See descriptions and course listings under Life Sciences, page 261.

EXTENSION EDUCATION

This program leads to the professionsl degree of Master of Extension Education and is open to persons holding a bachelor's degree in agriculture, home economics, or a closely related area. Admission to the program requires a grade-point average of at least 3.5 for the last sixty semester hours of undergraduate work.

Candidates are required to complete a minimum of eight units, and nine units are required if a thesis is not submitted. Three of these units must be in 400-level courses with one unit in the major field. A major (four units) may be taken in agriculture, home economics, or the social sciences. Students majoring in agriculture or home economics select four additional units from the social sciences; those majoring in the social sciences select four additional units from agriculture or home economics. All courses selected must be approved by the student's adviser. If a thesis is not submitted, the ninth unit may be selected in any area approved by the adviser. Students majoring in home economics must take work in three of the four major divisions of the department, unless proficiency in one or more of the areas is demonstrated by examination. At least four units must be earned in residence on the Urbana campus. Total extramural credit can not exceed three units.

Inquiries concerning the Master of Extension Education should be directed to Professor Ernest W. Anderson, 116 Mumford Hall.

FINANCE

The Department of Finance offers graduate work leading to the Master of Science and Doctor of Philosophy in Finance. The following fields are available for specialization within the department: money, credit, and banking; corporation finance; corporation history; investment; insurance; urban land utilization.

The grade-point average required for admission to graduate study in the department is 4.0, although applications of students with averages below 4.0 but above 3.75 may be considered on an individual basis. A candidate for a degree in finance must also meet the general admission requirements of the Graduate College. He must also have had (1) at least twenty-seven hours of undergraduate work in social science, fifteen hours of which must have been in economics, including a course in principles of economics and other courses for which the course in principles is a prerequisite, (2) credit in the courses in mathematics and statistics required for the bachelor's degree from the College of Commerce and Business Administration at the University of Illinois, or their equivalent, and (3) sufficient background in the finance area and the related fields of accountancy and business administration to support, in the judgment of the graduate adviser, the candidate's educational objective.

A candidate who elects finance as a minor for either the master's degree or the doctorate must have had (1) at least twelve hours of undergraduate work in social science, eight hours of which must have been in economics, including a course in principles of economics and other courses for which the course in principles is a prerequisite, and (2) sufficient background in the finance area and in the related fields of accountancy and business administration to support, in the judgment of the graduate adviser, the candidate's educational objective.

One year of graduate study in economic theory and a thesis are required as part of the minimum eight units for the master's degree in finance.

A doctoral candidate in finance must obtain credit in Mathematics 143, the second course in calculus at the University of Illinois, or its equivalent, and in Economics 470, Economic Statistics, or its equivalent. Graduate study in accountancy or statistics, or both, is advised strongly for such candidates. For the Doctor of Philosophy a candidate must pass a preliminary examination.

The Doctor of Philosophy program for the first year must include (1) two units of economic theory, (2) four units of finance, and (3) two additional units in finance or related fields. Two of the finance units should be in thesis research. The second year of study includes eight units which provide (1) a concentration in finance, (2) understanding of one or more fields in economics in addition to economic theory, and (3) proficiency in any other related minor field offered.

FACULTY

Professors: P. M. Van Arsdell (Head of Department), C. T. Arlt, R. W. Mayer, R. I. Mehr, R. C. Osborn.
Associate Professors: W. R. Bryan, T. E. Cammack, J. W. Leonard.
Assistant Professors: J. R. Cooper, S. W. Forbes, J. A. Gentry, C. M. Linke.

COURSES FOR GRADUATES

420. Central Banking Policy. An examination of modern theories of monetary management, gold standard theories, central banking, fiscal policy, debt management, and their relation to monetary policy. 1 unit. Arlt.

425. The Money Market and Financial Stabilization. A study of interest rate determination; the structure and operations of the money and capital markets; the objectives and implementation of monetary, fiscal, and debt management policies. 1 unit. Prerequisite: Finance 150. Arlt.

427. Commercial Bank Management. A study of the principal policies and problems which confront top management. Major emphasis is given to liquidity, loans, investments, deposits, and capital funds, but consideration is also given to bank statements, organization structure, operations, personnel, cost analysis, and public relations. Instructional methods utilize readings, cases, and research projects. 1 unit. Prerequisite: Finance 150. Bryan.

450. Theory of Financial Management. The objective of this course is to develop an analytical framework which represents the underlying theory of finance and its interrelationship to the total system within the firm. Necessary to this approach is the develop-

ment of a perspective for both internal and external approaches to financial management. 1 unit. Prerequisite: Finance 254 or equivalent; Mathematics 132 or equivalent; Economics 470 or equivalent. LINKE.

452. Investment Behavior. Investment behavior is examined by mathematical, statistical, and behavioral science models. The models provide the basis for analyzing portfolio selection, capital market price behavior, financial institution investment behavior, and stock price behavior. 1 unit. Prerequisite: Mathematics 134 or equivalent; Economics 470 or equivalent. GENTRY.

454. Corporation Finance. Nature of corporation finance and its relation to economics, accounting, and law; development of business corporation; concepts of capital, capitalization, and capital stock; nature of equities in corporation; financial analysis and interpretation; nature and development of financial plans; corporate securities and their adaptation to financial plan; initial and promotional financing; current capital financing; income administration; refinancing. 1 unit. Prerequisite: Finance 254. VAN ARSDELL.

455. Corporation Finance. Expansion; consolidation, concentration, and intercorporate relations; the corporate institution and the problem of monopoly and competition; corporate failure and reorganization; corporate financial management and the economy. 1 unit. Prerequisite: Finance 254. VAN ARSDELL.

456. Investment. A study of the financial process by which savings are transformed into capital; theories of investment value and of portfolio composition; critique of individual and institutional portfolio policies; survey of investment literature. 1 unit. MAYER.

460. Theory of Insurance. A study of the nature and cost of risk in our economic society and of the methods of handling it. 1 unit. MEHR.

470. Risk Management and Control. Same as Business Administration 555. An analysis of the risk management problem in the business enterprise with emphasis on methodology for risk analyses, techniques for risk and loss control, models for risk management decision-making, and procedures for administering risk management policy relating to non-speculative (insurable) risk. 1 unit. Prerequisite: Business Administration 552 and 560, their equivalents, or consent of instructor. MEHR.

490. Individual Study and Research. Directed reading and research. ½ to 1 unit. STAFF.

499. Thesis Research. Required for those writing master's and doctor's theses in finance. 0 to 4 units. MEHR.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

340. Consumer Finance. Nature and importance of consumer finance; trends in consumer credit; instruments and institutions of consumer credit; economic effects of consumer finance; consumer credit and public policy. ½ to 1 unit. Extra work is required of graduate students who register for 1 unit. Prerequisite: Finance 150 and 254, or consent of instructor.

350. Capital Investment Management. Designed to develop an understanding of the complex problems related to financial management; the development of an analytical framework for capital investment decision making; the study of capital investment problems through the use of selected cases. ½ to 1 unit. Prerequisite: Finance 254. GENTRY.

357. Financing Small Business. Size and nature of small business; significance and limitations of small business; financial structure and problems; financial assistance to small business; future prospects of small business. ½ to 1 unit. Prerequisite: Finance 254 or 257. OSBORN.

359. Securities Analysis. Portfolio selection in theory and practice; application of analytical principles and techniques to fixed income securities, common stocks, and senior securities with speculative features; efficient income/risk selection of securities. ½ to 1 unit. Prerequisite: Accountancy 108; Finance 254. MAYER.

360. Employee Benefit Plans. Same as Labor and Industrial Relations 360. An analysis of the economic and financial issues involved in designing and administering employee benefit plans; major emphasis is given to group life, disability income, and medical care plans and to "qualified" pensions and profit-sharing plans for regular employees; some attention is given to special supplementary plans for the executive employees. ½ to 1 unit. Prerequisite: Finance 260, Economics 240, or Industrial Administration 351; or consent of instructor. MEHR.

363. Estate Planning. A study of the application of life insurance to the problems of family security, business security, investments, and estate protection. ½ to 1 unit. Prerequisite: Finance 262. MEHR.

368. Survey of Urban Real Estate. A broad survey of the field of real estate and urban land economics. Particular emphasis is given to the factors determining real estate values, the techniques of real estate valuation, and the principles of land utilization, development, management, marketing, and financing. Credit is not allowed for both Finance 264 and Finance 368. ½ to 1 unit. Prerequisite: Six hours of economics or consent of instructor. COOPER.

369. Urban Land Problems. A problems course for students interested in undertaking detailed analysis of urban land problems. Problems are selected for individual study. Whenever possible the problems are selected and developed jointly with the departments of Urban Planning, Landscape Architecture, Architecture, and others. ½ to 1 unit. Prerequisite: Finance 264 or 368, or consent of instructor. COOPER.

370. Risks and Risk Management. Analysis of the financial problems in the risks of property damage or bodily injury in business situations and evaluation of the alternative methods of dealing with such problems. ½ to 1 unit. Prerequisite: One of the following: Accountancy 105 or 201; Economics 103 or 108; Finance 254 or 257. FORBES.

371. Property and Liability Insurance. A survey course involving an analysis of (1) the insurance product, (2) financial aspects of the property-liability insurance enterprise, (3) governmental regulation of the property-liability insurance enterprise, (4) current social issues involving property-liability insurance, and (5) economic aspects of the property-liability insurance industry. ½ to 1 unit. Prerequisite: Finance 260. FORBES.

FOOD SCIENCE
(Including Dairy Technology)

The Department of Food Science offers graduate work leading to the Master of Science and Doctor of Philosophy in Food Science or Dairy Technology.

A student planning to major in food science should have a Bachelor of Science degree in a recognized field of biological, physical, agricultural, or engineering science with credit in the following specific areas: physics, eight hours; calculus, five hours; physical chemistry, four hours. Students lacking these requirements will have an opportunity to fulfill them.

In order to major in dairy technology, a student should have a Bachelor of Science degree in any of the above listed fields of science.

The grade-point average required for admission to graduate study is 3.75, but applications from students with averages below 3.75 but above 3.5 may be considered on an individual basis.

Master of Science.

Food Science. To obtain a master's degree in food science, a student must have credit in Chemistry 350 and 355 (biochemistry), Microbiology 311 and 312, and Food Science 301, 302, 421 (one-fourth unit), and 499 (two units). The remainder of the eight units of credit required for the Master of Science consist of graduate courses selected from inside and/or outside the department which, in the opinion of the student and his adviser, are appropriate for the training and development of the student in the field of his specialization.

Thesis research may be carried out in any one of the following fields of specialization:

food chemistry, food engineering, food microbiology, and food processing. The student must present a thesis on his research and is required to take an oral examination covering the field of general food science and his specialization.

Dairy Technology. To obtain a master's degree in dairy technology, a student must have credit in Chemistry 350 and 355, Dairy Technology 401, 404 (one-fourth unit), and 499 (two units). A course in statistics (graduate or undergraduate) is also required.

The general provisions for a Master of Science in dairy technology are the same as in food science except that the fields of specialization apply to dairy products and the master's examination covers the field of dairy technology.

Doctor of Philosophy.

Food Science. In addition to the courses required for the Master of Science degree, candidates for the degree of Doctor of Philosophy in food science must have additional credit in Food Science 421 (one-fourth unit) and 499 (eight units). The remainder of the sixteen units of credit required for the degree will consist of graduate courses selected from inside and/or outside the department which in the opinion of the student and his adviser are appropriate for the training of the student in his field of specialization. In addition, the candidate must demonstrate proficiency in one foreign language, as approved by his adviser, in which adequate scientific literature exists and which is neither his native tongue nor English. Also he must complete a special option approved by his adviser which may be counted as part of the sixteen required units of credit. Upon the completion of all formal courses, language and special option requirements, or during the last semester of the course work, the student is required to take a series of written preliminary examinations in food science. The final eight units after passage of the preliminary examination must be spent on thesis research. Upon the submission of his thesis, the candidate is required to defend his thesis orally before a faculty committee.

Dairy Technology. In addition to the courses required for the Master of Science degree, candidates for the degree of Doctor of Philosophy in dairy technology must have credit in Dairy Technology 403 and 404 (one-fourth unit) and 499 (eight units). They are also required to attend all seminars in dairy technology (Dairy Technology 404). The general provisions for a Doctor of Philosophy in dairy technology are the same as in food science, except that the written preliminary examinations for the doctorate are in the fields of dairy technology, dairy chemistry, and dairy microbiology.

FACULTY

Professors: R. T. Milner (Head of Department), H. H. Draper, J. H. Hetrick, F. A. Kummerow, A. I. Nelson, Z. J. Ordal, M. P. Steinberg, J. Tobias, S. L. Tuckey, R. M. Whitney, L. D. Witter.

Associate Professors: Betty E. Haskell, T. Nishida, E. G. Perkins, L. Wei, H. K. Wilson.

Assistant Professors: C. Argoudelis, K. A. Narayan, D. Sgoutas.

Food Science

COURSES FOR GRADUATES

404. Special Topics in Food Science, III: Technology of Fats and Oils. A study of the commercial technology of fats and oils, including soaps and protective coating. Offered in 1970-1971 and in alternate years. ½ unit. Prerequisite: Food Science 391 or consent of instructor. Narayan.

406. Special Topics in Food Science, IV: State and Metabolism of Lipids. An advanced study of the state of lipids in animal tissues and in biological fluids, and of the metabolism of lipids in relation to dietary fats and other food constituents. Offered in 1970-1971 and in alternate years. 1 unit. Prerequisite: Chemistry 350 or consent of instructor. Nishida.

421. Seminar. Discussions on specialized topics and current literature relating to food technology. Required of all graduate students in food science. ¼ unit. Staff.

430. Carbohydrates in Foods. Same as Home Economics 430. A study of the physical and chemical properties of carbohydrates used in foods and their behavior under conditions encountered in food processing and storage. 3/4 unit. Prerequisite: Chemistry 355, 354, or consent of instructor.

440. Design and Analysis of Biological Experiments. Same as Agricultural Engineering, Agronomy, Animal Science, Dairy Science, Forestry, Horticulture, and Veterinary Medical Science 440. Statistical methods as tools for research. Principles of designing experiments and methods of analysis for various kinds of designs, including factorial experiments, are considered from the viewpoint of when and how to use them. 3/4 unit. Prerequisite: Food Science 340 or equivalent.

499. Thesis Research. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Special Problems. Supervised research on special problems in food science and dairy technology. Prerequisite: Written consent of instructor must be obtained prior to enrollment. 3/4 to 1 1/4 units in one semester; maximum two units allowable credit.

301. Food Processing. Lectures, discussions, and pilot-plant demonstrations and experiments in preservation of foods by canning, freezing, dehydrating, and fermenting methods. Evaluation of product quality by subjective and objective methods and consideration of factory quality control factors. Field trips to commercial food plants. 1 unit. Prerequisite: Chemistry 133; Food Science 201. NELSON, WEI.

302. Food Processing. Lectures, discussions, and pilot-plant demonstrations and experiments in food manufacture including formulation of food preparations from fruits, vegetables, and cereals; preservation of meats and poultry products; vacuum and freeze drying of foods; evaluation of product quality by subjective and objective methods and consideration of factory quality control factors. Field trips to commercial food plants. 1 unit. Prerequisite: Chemistry 133; Food Science 202 and 301. NELSON, WEI.

324. Problems in Nutrition. Same as Home Economics 324. Discussions and investigations. 1/2 or 1 unit. Prerequisite: Home Economics 220; Biochemistry 354 or 350 and 355; senior standing. HASKELL.

332. Principles of Sanitation in the Processing and Handling of Foods. A study of the principles of sanitation with appropriate emphasis on practical considerations as they apply to various food processing industries. Control of insects, rodents, and microorganisms; fundamentals of detergency; sanitation of water supplies; waste disposal methods; government and public health regulation. Local field trips to food processing plants. 1/2 unit. Prerequisite: Microbiology 100 and 101; Chemistry 102. ORDAL, WITTER.

340. Introduction to Applied Statistics. Same as Agricultural Engineering, Agronomy, Animal Science, Dairy Science, Food Science, Forestry, Horticulture, and Veterinary Medical Science 340. Statistical methods involving relationships between populations and samples; collection, organization, and analysis of data; techniques in testing hypotheses with an introduction to regression, correlation, and analyses of variance limited to the completely randomized design and the randomized complete-block design. 3/4 unit. Prerequisite: Mathematics 104 or 111 or 112, or equivalent.

363. Introduction to Process Engineering. Same as Chemical Engineering 363. Fundamentals of heat transfer, fluid flow, evaporation, drying, and other unit operations in the process industries. For students in chemistry, engineering, and food science; not open to majors in chemical engineering. Lectures and problems. 3/4 unit. Prerequisite: Calculus or consent of instructor. STEINBERG.

373. Advanced Food Microbiology. A study of the microbiology of those foods, food processes, or food ingredients, the production of which involves the biological or enzymatic activities of bacteria, yeasts, or the higher fungi. Offered in 1971-1972 and in alternate years. 1 1/4 units. Prerequisite: Chemistry 133; Microbiology 311 and 312. ORDAL, WITTER.

391. Special Topics in Food Science, I: Chemistry of Lipids in Foods. A detailed survey of the chemical and physical properties of lipids. Offered in 1970-1971 and in alternate years. ½ unit. Prerequisite: Credit or registration in Chemistry 350 or consent of instructor. PERKINS.

393. Special Topics in Food Science, II: Experiments in Lipid Chemistry. Laboratory exercises, demonstrations, and assigned readings. Offered in 1970-1971 and in alternate years. ¾ unit. Prerequisite: Registration in Food Science 391 or consent of instructor. ARGOUDELIS.

Dairy Technology

COURSES FOR GRADUATES

401. Advanced Principles of Dairy Technology. Study of fundamentals and fundamental problems involved in the processing of milk and milk products. Offered in 1970-1971 and in alternate years. 1 unit. Prerequisite: Chemistry 350. HETRICK.

403. Colloid Phenomena of Dairy and Other Food Products. A study of the colloidal phenomena involved in the processing of dairy and other food products. Offered in 1970-1971 and in alternate years. 1 unit. Prerequisite: Consent of instructor. WHITNEY.

404. Seminar. Review of current literature in dairy technology. ¼ unit; students may register for credit only twice for a maximum of one-half unit. STAFF.

499. Thesis Research. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. Dairy Plant Management. Problems in the organization, financing, labor management, and operation of dairy plants. ¾ unit. Prerequisite: Consent of instructor. WILSON.

310. Dairy Product Processing. Theory and practice of receiving, preheating, pasteurizing, sterilizing, and homogenizing milk and cream for market, cultured milk and cream, powdered cream, frozen milk and cream, concentrated milk, dried milk, and ice cream. 1 unit. Prerequisite: Food Science 201; Dairy Technology 211; credit or registration in Dairy Technology 213. HETRICK.

311. Dairy Product Processing. Theory and practice of the processing and manufacture of dairy products which are relatively nonperishable, such as butter, butter oil, cheese, casein, lactic acid, lactose, and fermentation products of whey. 1 unit. Prerequisite: Dairy Technology 211 and 213. TUCKEY.

312. The Chemistry of Milk and Milk Products. Chemical composition of dairy products and the chemical changes that occur during their manufacture and storage. Offered in 1970-1971 and in alternate years. ¾ unit. Prerequisite: Chemistry 133; Dairy Technology 213 or Chemistry 122. WHITNEY.

FORESTRY

The Department of Forestry offers graduate work leading to the degree of Master of Science in Forestry. Applicants for admission must have a grade-point average of at least 3.75 for the last sixty hours of undergraduate study.

The prerequisite for graduate study is a bachelor's degree in forestry or a closely related field. Depending upon their backgrounds, non-forestry graduates may be required to complete certain basic forestry courses in addition to their regular degree requirements. Programs are designed to serve the needs of each student and to deepen his understanding of a particular phase of forestry such as ecology, economics, entomology, genetics, mensuration, physiology, soils, statistics, or wood science.

To qualify for this degree, a student must earn eight or more units of graduate credit with at least three units in courses at the 400 level. In most cases, a thesis based on original research

is required. The thesis requirement may be waived if, in the judgment of the departmental graduate faculty, such waiver will result in a better program for an individual student. Forestry seminar is required of all graduate students. Advanced courses in special interest fields are found in such areas as biometrics, botany, climatology, economics, engineering, entomology, genetics, geography, mathematics, plant pathology, and soil science (see under departmental listings).

FACULTY

Professors: W. R. Boggess (Head of Department), I. I. Holland, C. S. Walters.
Associate Professors: A. R. Gilmore, J. J. Jokela, R. G. Rennels.

COURSES FOR GRADUATES

400. Seminar. Discussions on specialized topics and current literature in forestry. Required of all graduate students in forestry. 1/4 unit; may be taken twice for a total credit of one-half unit. Staff.

401. Special Problems. Individual studies or investigations in selected branches of forestry. 1/2 to 1 unit. Not more than one unit may be offered for an M.S. degree. Staff.

414. Discussions in Forest Ecology and Physiology. Individual and group discussions of developments and techniques in forest ecology and physiology based on classic and current literature. 1/4 unit; total credit limited to one unit. Prerequisite: Consent of instructor.

440. Design and Analysis of Biological Experiments. Same as Agricultural Engineering, Agronomy, Animal Science, Dairy Science, Food Science, Horticulture, and Veterinary Medical Science 440. Statistical methods as tools for research. Principles of designing experiments and methods of analysis for various kinds of designs, including factorial experiments, are considered from the viewpoint of when and how to use them. 3/4 unit. Prerequisite: Forestry 340 or equivalent.

499. Thesis Research. Research may be conducted in various phases of forestry. Subject must be approved by departmental committee. 1 to 3 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

316. Environment and Tree Growth. Growth and development of forest trees as related to environmental factors, with special emphasis on micro-site changes induced by silvicultural practices. Completion of a special project required for graduate credit. 1 unit. Prerequisite: Forestry 211 or consent of instructor.

340. Introduction to Applied Statistics. Same as Agricultural Engineering, Agronomy, Animal Science, Dairy Science, Food Science, Horticulture, and Veterinary Medical Science 340. Statistical methods involving relationships between populations and samples; collection, organization, and analysis of data; techniques in testing hypotheses with an introduction to regression, correlation, and analyses of variance limited to the completely randomized design and the randomized complete-block design. 3/4 unit. Prerequisite: Mathematics 104 or 111 or 112, or equivalent.

362. Forest Entomology. A study of the characteristics, life histories, and forest relationships and controls of the economically important forest insects of the United States. 3/4 unit. Prerequisite: One year of biological science; one year of chemistry. Rennels.

FRENCH

The Department of French offers graduate work leading to the Master of Arts, Master of Arts in the Teaching of French, and Doctor of Philosophy.

Students are admitted with a minimum grade-point average of 4.0. Applications of

students with grade-point averages below 4.0 but above 3.5 are considered on an individual basis.

Students electing French as a major subject should have had a college major in French, including practical work in the use of the language and advanced work in literature. Some knowledge of other Romance languages and literatures is desirable. A reading knowledge of Latin based on three years of high school Latin or three semesters of college Latin and a reading competence in German are required for the doctorate.

Students choosing French as a minor subject are admitted to courses for which they are adequately prepared.

Master of Arts in French. In addition to fulfilling the general requirements of the Graduate College, candidates must pass an examination based on a general reading list. Candidates preparing to teach French must take French 311, 313, and 314 unless they can demonstrate proficiency.

Doctor of Philosophy in French. Candidates are expected to take at least two units in seminar courses. Candidates also are required to include two units in Old French philology, for which some knowledge of Latin is essential. These courses may be counted as a first minor subject. French 406 also is required.

Master of Arts in the Teaching of French. Candidates for the Master of Arts in the Teaching of French must earn four units in French, two units in education, and two units in electives. Requirements are French 311, 313, 314, two units; two of the following courses: History and Philosophy of Education 303, 304, 305, one unit; and Educational Psychology 311 and 312, one unit. The elective courses in French and the other electives must be selected with the approval of the adviser. The electives may be in French, in education, or, in exceptional cases, in other fields. See pages 36 and 37.

FACULTY

Professors: B. H. Mainous (Head of Department), E. Jahiel, F. Jost, C. A. Knudson, P. Kolb, F. W. Nachtmann, R. J. Nelson, Y. Velan, C. P. Viens.
Associate Professors: Barbara C. Bowen, V. E. Bowen, H. C. De Ley, S. E. Gray, F. M. Jenkins, M. K. Myers.
Assistant Professors: N. Laprevotte, L. B. Price, E. Talbot.

COURSES FOR GRADUATES

400. Beginning French for Graduate Students. Basic grammar and vocabulary; reading practice. Designed for graduate students desiring help in preparing for the French reading requirements for the Ph.D. 4 semester hours. No graduate credit.

401. Reading French for Graduate Students. Grammar, vocabulary, general and special reading. Designed for graduate students desiring help in preparing for the French reading requirements for the Ph.D. 4 semester hours. No graduate credit. Prerequisite: French 400, or French 101 and 102, or equivalent.

403. The Study of Culture: Fine Arts, History, and Literature, I. Master works studied with a special view to their presentation in foreign language programs in secondary schools and in junior colleges. Designed for students in the program for the Master of Arts in the Teaching of French. 1 unit. Prerequisite: Admission to the program for the Master of Arts in the Teaching of French.

404. The Study of Culture: Fine Arts, History, and Literature, II. Master works studied with a special view to their presentation in foreign language programs in secondary schools and in junior colleges. Designed for students in the program for the Master of Arts in the Teaching of French. 1 unit. Prerequisite: French 403 or consent of instructor.

405. Teaching College French. A study of the problems of teaching French at the college level, including classroom procedures and language laboratory techniques. No credit.

Note: In any given year a selection from the following courses is offered. For current information, consult the department office or the current semester Time Table.

425. Explication de textes, I. Exercises according to the method of *explication de textes*, applied to texts selected principally from the period 1944-1958. 1 unit.

433. Studies in Sixteenth-Century French Literature, I. Major writers of the sixteenth century studied with reference to the most important intellectual and religious preoccupations of their century. 1 unit.

434. Studies in Sixteenth-Century French Literature, II. Themes and techniques of major poets and poetic schools of the sixteenth century. 1 unit.

435. Studies in Seventeenth-Century French Literature, I. 1 unit.

436. Studies in Seventeenth-Century French Literature, II. 1 unit.

437. Studies in Eighteenth-Century French Literature, I. 1 unit. V. E. Bowen, Jost.

438. Studies in Eighteenth-Century French Literature, II. 1 unit. V. E. Bowen, Jost.

439. Studies in Nineteenth-Century French Literature, I. Studies in nineteenth-century literature to 1850. 1 unit. Talbot.

440. Studies in Nineteenth-Century French Literature, II. Studies in nineteenth-century literature after 1850. 1 unit.

441. Studies in Twentieth-Century French Literature, I. In French. Twentieth-century poets and novelists. 1 unit. Gray.

442. Studies in Twentieth-Century French Literature, II. 1 unit. Gray.

443. French Studies. A flexible course limited only by the concentration of its material in French. May be activated by student request or faculty proposal. 1 unit.

446. Research Methods. Orientation in graduate research, introduction to bibliographical problems, and survey of methodology for papers and dissertations. ¼ or ½ unit. Price.

448. Studies in French Descriptive Linguistics. Selected specialized topics in the morphology, derivation, and syntax of contemporary standard French; topics vary each semester, e.g., verb morphology, noun derivation, interrogative systems, nominal phrases. 1 unit. Prerequisite: French 316.

449. Introduction to Old French Language and Literature. Training in reading Old French (twelfth and thirteenth centuries), outline of Old French grammar, reading of characteristic works, outlines of literary history. 1 unit.

450. Historical French Grammar. A study of the development of the French language, principally Old French from Latin. 1 unit. Prerequisite: French 449; an elementary knowledge of Latin.

451. Studies in Medieval French Literature. Close study of one or more topics in Old French literature. 1 unit. Prerequisite: Consent of instructor.

455. History of French Literary Criticism. Literary theory and practice of criticism as developed in France from the sixteenth to the twentieth centuries. Analysis and discussion of preoccupations, critical methods, and approaches to literature of representative critics, with emphasis upon emergence of philosophies of criticism. 1 unit.

456. Studies in Recent French Criticism. Study of important trends in French literary criticism of the mid-twentieth century, relating these trends to critical problems and theories of literature of the late nineteenth century and the earlier part of the twentieth. 1 unit.

462. Introduction to Romance Linguistics. See Linguistics 462. ½ unit. Prerequisite: Four semesters of a Romance language or Latin, or equivalent.

467. Old Provençal Historical Grammar. The phonology, morphology, and syntax of the Old Provençal language with emphasis on its Latin origins; illustrative reading of selected

prose works. Lectures are in English. 1 unit. Prerequisite: Consent of instructor.

468. Old Provençal Literature. Selected readings of various *genres*, emphasizing lyric poetry, with attention to its position in European literature. Lectures are in English. 1 unit. Prerequisite: French 467 or consent of instructor.

470. Seminar in Old French Literature. Discussion and research on some specialized topic in Old French literature. Topic announced in advance. 1 unit. Course may be repeated for credit.

471. Seminar in Sixteenth-Century French Literature. Discussion and research on some specialized topic in sixteenth-century French literature. Topic announced in advance. 1 unit. Course may be repeated for credit.

472. Seminar in Seventeenth-Century French Literature. Discussion and research on some specialized topic in seventeenth-century French literature. Topic announced in advance. 1 unit.

473. Seminar in Eighteenth-Century French Literature. Discussion and research on some specialized topic in eighteenth-century French literature. Topic announced in advance. 1 unit. Course may be repeated for credit.

474. Seminar in Nineteenth-Century French Literature. Discussion and research on some specialized topic in nineteenth-century French literature. Topic announced in advance. 1 unit. Course may be repeated for credit.

478. Seminar in Twentieth-Century French Literature. Discussion and research on some specialized topic in twentieth-century French literature. Topic announced in advance. 1 unit. Course may be repeated for credit.

479. Seminar in French Literature. Discussion and research on some specialized area in French literature. Topic announced in advance. Course may be repeated for credit. 1 unit.

485. Seminar in Proust, I. Offered in 1970-1971 and in alternate years. $\frac{1}{2}$ unit. Prerequisite: French 342 or consent of instructor. KOLB.

486. Seminar in Proust, II. Offered in 1970-1971 and in alternate years. $\frac{1}{2}$ unit. Prerequisite: French 342 or consent of instructor. KOLB.

491. Individual Topics. $\frac{1}{4}$ to 1 unit. STAFF.

499. Thesis Research. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

Note: The prerequisite for all courses in this group is French 201 and 202, or equivalent.

311. Diction. Training in the improvement of French pronunciation, with special attention to the problems of teachers. It is recommended that this course and French 313 be taken concurrently. $\frac{1}{2}$ unit. Prerequisite: Consent of instructor. VIENS.

313. Phonetics. A systematic study of the sounds and sound patterns of French. It is recommended that this course and French 311 be taken concurrently. $\frac{3}{4}$ unit. Prerequisite: Consent of instructor. JENKINS, MYERS.

314. Syntax. An advanced theoretical and practical study of present-day French, with some consideration of stylistics. $\frac{3}{4}$ unit. Prerequisite: French 213 and 214, or 215, or equivalent.

315. Stylistics. Linguistic analysis of a variety of French prose styles to illustrate the range of expressions for the same or similar ideas. Translation into French of fairly difficult English prose; occasional directed composition. $\frac{3}{4}$ unit. Prerequisite: French 314.

316. Structure of the French Language. Same as Linguistics 316. A general survey of the linguistic structure of modern standard French, including phonology, morphology, and syntax. Emphasis on the differences between its spoken and written forms. $\frac{3}{4}$ unit. Pre-

requisite: French 313 or equivalent training in phonetics. JENKINS.

335. French Civilization, I. In French. A survey of French life and French institutions, intended as a background for literary studies and as a preparation for the teaching of French. 3/4 unit.

336. French Civilization, II. 3/4 unit.

341. Lectures de Proust, I. *A la recherche du temps perdu.* Readings and textual explication in Marcel Proust's novel. Course covers approximately one-half of Proust's novel. 1/2 unit. Prerequisite: French 201 and 202, or equivalent.

342. Lectures de Proust, II. *A la recherche du temps perdu.* Readings and textual explication in Marcel Proust's novel. Course covers second half of Proust's novel. 1/2 unit. Prerequisite: French 341 or consent of instructor.

382. Language Laboratory Techniques. Same as German, Slavic, and Spanish 382. Instruction and practice in the techniques of making foreign-language tapes and integrating them with classroom activity; instruction in the problems of planning and operating a language laboratory. 1/2 unit. Prerequisite: Three years of a modern foreign language at the college level, or equivalent. MYERS, NACHTMANN.

GENERAL ENGINEERING

The courses listed below may be taken for graduate credit by students whose advisers approve their selection as satisfying part or all of the requirements for a minor for the master's degree.

FACULTY

Professors: J. S. DOBROVOLNY (Head of Department), B. O. LARSON, E. C. MCCLINTOCK, J. E. PEARSON.
Associate Professors: R. J. PLACEK, F. L. SPALDING.
Assistant Professors: H. STREETER, L. WOZNIAK.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

304. Professional Expression. Reading and critical study of significant authors from Plato to W. H. Whyte, selected for their contributions to intellectual breadth, imagination, and perfection of style. Original projects allow coordination with seminar and other content courses, and permit the mature student to gain any needed knowledge of reports, administrative correspondence, and articles for publication. 1 unit. Prerequisite: Consent of instructor. MCCLINTOCK.

313. Advanced Methods in Engineering Graphical Computations. Application of determinants in the theory and construction of engineering nomograms; curve fitting and formulation of empirical formulae; methods and application of graphical calculus. 1/2 to 1 unit. Prerequisite: Mathematics 142 or equivalent. PLACEK.

330. Industrial Standardization. Evolution and history of standardization; local, national, and international standardization; governmental standardization. Special emphasis is placed on standardization procedures for individual industrial establishments. 1/2 unit. Prerequisite: Consent of instructor. SPALDING.

334. Introduction to Reliability Engineering. Same as Industrial Engineering 334. An introduction to concepts in engineering design, testing, and management for highly reliable components and systems. 3/4 or 1 unit. Prerequisite: Industrial Engineering 333, or Mathematics 361, or equivalent with consent of instructor.

360. Engineering Applications of Meteorological Fundamentals. The application of the fundamentals of meterology to engineering problems including the transport and

diffusion of particulate matter, aerosols, and gases; precipitation processes and rainout; behavior of stack effluents, explosion debris, and radioactive materials in the atmosphere. Applications to operation scheduling and to site selection. 1 unit. Prerequisite: Mathematics 142 or 143; Physics 106, 107, and 108; Mechanical Engineering 205 and 206, or 209, or Chemistry 342 and 344, or Physics 360. PEARSON.

393. Special Problems. Study of advanced problems related to general engineering and graphics. $\frac{1}{4}$ to 1 unit. Prerequisite: Consent of instructor. LARSON, STAFF.

GENETICS

A Doctor of Philosophy program in genetics is provided through the cooperative efforts of many different departments and is administered by the University Committee on Genetics. Training is available in molecular, microbial, developmental, population, quantitative, applied plant and animal, and behavioral genetics, and in cytogenetics and evolution. Experience is provided with a choice of organisms ranging from viruses to vertebrates. Students seeking master's degrees are directed to the various departmental programs, or to the master's program in biology offered by the School of Life Sciences.

Applicants for admission should have at least a 4.0 (B) average for the last sixty hours, but may, in special circumstances, be considered for admission with a 3.75 average. They should also have completed courses in quantitative and organic chemistry, trigonometry, analytic geometry, and one year of college physics. Calculus is strongly recommended.

During the first two years, candidates obtain a broad background in the major disciplines of genetics (molecular and microbial, population or quantitative, and cytogenetics), and complete courses or demonstrate proficiency in biochemistry, calculus, and statistics. During the first year, a program of study is determined by the student in consultation with his adviser and the Genetics Committee.

Thesis research may be carried out under the direction of any of the many staff members throughout the University. Candidates also usually elect minors in one of the biology departments and in either chemistry or mathematics, but other options are available.

Applicants are eligible for a variety of fellowships and teaching or research assistantships. Inquiries concerning the Genetics Program should be directed to the Director of the School of Life Sciences, 387 Morrill Hall.

GEOGRAPHY

The Department of Geography offers work leading to the Master of Arts, Master of Science, Master of Science in the Teaching of Geography, and Doctor of Philosophy. At the master's level, study programs emphasize research techniques and systematic geography; individual programs for the doctoral candidates stress specialization in particular fields of systematic and regional geography, work in cognate disciplines, and encouragement of individual research.

Students applying for admission to the master's programs must have a grade-point average of 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis. All candidates for master's degrees in geography must have an average of at least 4.25 in previous work in geography. Ph.D. candidates are expected to have at least a 4.5 average.

Additional information regarding degree program requirements may be obtained from the Head of the Department, 220 Davenport Hall.

Master of Arts or Master of Science in Geography. Successful candidates for the master's degree whose backgrounds are largely in physical geography are recommended for the Master of Science; others receive the Master of Arts. At least four of the minimum of eight units of graduate credit required for the master's degree must be in geography, and all eight may be in geography. The adviser for candidates for these degrees is Professor J. D. FELLMANN.

Master of Science in the Teaching of Geography. Candidates for this degree must earn four units in geography, two of which are geography electives, two units in education, and two units in electives. Requirements are Geography 495, two units; two of the following courses: History and Philosophy of Education 301, 302, 303, 304, one unit; and Educational Psychology 311 and 312, one unit. Two electives must be in geography and the other two in geography, education, or, in exceptional cases, other fields. The grade-point average required for admission is 3.5. See pages 36 and 37. The adviser for candidates is Professor F. W. Foster.

Doctor of Philosophy. The doctoral student is expected to penetrate deeply into specific phases of geographic study, including one physical systematic field, one cultural systematic field, and one major region of the world. The adviser for candidates is Professor J. Thompson.

FACULTY

Professors: J. Thompson (Head of Department), C. S. Alexander, J. P. Augelli, A. W. Booth, J. D. Fellmann, F. W. Foster, J. H. Garland, H. G. Roepke, J. A. Russell, D. B. Shimkin.
Associate Professor: J. F. Lahey.
Assistant Professors: J. A. Jakle, N. R. Nunnally, C. C. Roseman.

COURSES FOR GRADUATES

412. Analytical Climatology. A detailed consideration of the character and causes of the climates of certain selected areas; the application of various criteria as bases for climatic differentiation. 1 unit. Prerequisite: Geography 111; Geography 313 or equivalent; consent of instructor. Lahey.

421. Regional Concepts in Geography. Theories of regionalism, nature of the geographic region, the unique position of regionalism in a total geographic philosophy; regionalism in applied geography. ½ unit. Prerequisite: Nine hours of regional geography. Garland.

429. The Evolution of Agricultural Economies. Same as Agronomy and Anthropology 429. The problems concerning the development of the several basic food crop economies are studied from the point of view of geographical environment, the available archaeological and ethnographic evidence, and from the point of view of agronomy and plant genetics. The regional emphasis varies from year to year. 1 unit. Prerequisite: Consent of instructor. Alexander, Thompson.

461. Fundamentals of Bioclimatology. Same as Physiology 461. The effects of physical factors (such as barometric pressure, temperature, humidity, radiation, and air movement) on physiological processes in mammals; and the application of meteorological, climatological, and geographical techniques in physiological studies. ¾ unit. Prerequisite: Consent of instructor.

462. Experimental Bioclimatology. Same as Physiology 462. Laboratory work and demonstrations on methods of measuring meteorological factors, of clinical thermometry, and of partitional calorimetry; laboratory work on physiological adjustments of man to heat, cold, and high altitude. ½ unit. Prerequisite: Physiology 301, or 401 and 402; credit or registration in Geography 461.

463. Historical Geography. Objectives and methods of historical geography. 1 unit. Jakle, Russell.

464. Advanced Human Bioclimatology. Same as Physiology 464. Topics in human bioclimatology and medical geography, such as climatic determinism, meteorotropism, the weather elements as stresses, and acclimatization. ½ unit. Prerequisite: Geography 461.

473. Problems in Cartography. Subjects for map presentation are selected in the student's field of specialization or area of interest. Data are collected and maps compiled and carried to completion in final drafted form suitable for publication. 1 unit. Prerequisite: Geography 373 or consent of instructor. Foster.

477. Area Analysis. Individual analysis of areas in the vicinity of Urbana. 1 unit. Foster.

478. Advanced Field Geography. A graduate course in the theory and application of geographical field techniques to the analysis of areas, culminating in individual reports on assigned problems in the field course area. S; 1¼ to 2 units. STAFF.

495. Advanced Studies in Geography. Directed and supervised detailed investigation of selected problems or regions. Designed to develop ability to conduct independent investigation. ½ to 2 units. Work may be taken in the following fields:

- **(a) Physical Geography, Africa, Agricultural Origins.** ALEXANDER.
- **(b) Cultural, Latin America.** AUGELLI.
- **(c) Asia, Resource Management, Transportation.** BOOTH.
- **(d) Urban Geography, U.S.S.R.** FELLMANN.
- **(e) Middle East, Advanced Cartography, Field Methods.** FOSTER.
- **(f) Anglo America, Political Geography, Regionalism.** GARLAND.
- **(g) Economic Geography, Industrial Location, Europe.** ROEPKE.
- **(h) Europe, Marketing Geography.** RUSSELL.
- **(i) Human Ecology, U.S.S.R.** SHIMKIN.
- **(j) Cultural Geography, Latin America.** THOMPSON.
- **(k) Climatology, Meteorology.** LAHEY.
- **(l) Historical, Cultural, Population Geography.** JAKLE.
- **(m) Remote Sensing, Quantitative Methods, Field Methods.** NUNNALLY.
- **(n) Social Geography, Migration, Quantitative Methods.** ROSEMAN.

497. Development of Geographic Thought. A consideration of the various philosophies of geography and of the men who reflect them. ½ unit. FELLMANN.

499. Thesis Research. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

306. Maps and Cartobibliographical Aids. An examination of the problems involved in the acquisitions, care, and library use of maps. Classes become familiar with the major cartobibliographical and related aids. ½ unit. WHITE.

313. Climates of the Continents. A regional treatment of the climates of the world by continents. ¾ unit. Prerequisite: Geography 102 or consent of instructor. LAHEY.

314. Regional Problems in Conservation of Natural Resources. The distribution, use, and interrelationship of the resources in the various resource management regions of the United States, the conservation techniques applied to them, and the problems of public policy in their effective management. ¾ unit. BOOTH.

323. Geography of the North American Midwest. The core of the North American continent; detailed analysis of the functions and patterns of the Midlands and their external relations. ¾ unit. GARLAND.

331. Geography of Caribbean America. A survey of the physical elements and occupance sequences that distinguish the geographic regions of Mexico, Central America, Panama, and the West Indies. ¾ unit. AUGELLI.

332. Geography of South America. A regional geography of South America with emphasis on the southern hemisphere of that continent. ¾ unit. THOMPSON.

342. Geography of Europe. Influence of climate, surface features, and natural resources on the distribution of the people, their industries, and routes of trade; new boundaries and present economic problems in their geographic setting. ¾ unit. RUSSELL.

351. Geography of Asia. A regional geography of Asia with concentration on the monsoon realm of southern and eastern Asia. ¾ unit. STAFF.

353. Geography of the U.S.S.R. Physical and cultural regionalism; a survey of natural resources and patterns of human occupance including industry, agriculture, and transportation. ¾ unit. FELLMANN.

355. Geography of Central and South Africa. A regional geography of Africa south of the Sahara. ¾ unit. ALEXANDER.

357. Geography of the Middle East and North Africa. A regional geography of an area with limits largely defined in terms of Arab and Moslem influences or closely related cultural and historical circumstances. The course is oriented around the strategic centrality of the core of the territory as the crossroads of Europe, Asia, and Africa. 3/4 unit. Foster.

361. Geography of Agricultural Land Utilization. A geographic consideration of the nature of agricultural land utilization from the world, continental, and regional viewpoints. Special emphasis is on the geographical implications of various types of agricultural land use and upon the interrelationships between areas of different types of land utilization. 3/4 unit. Foster.

362. Geography of Manufacturing. An analysis of the factors bringing about geographical concentration of industry. Each of the major manufacturing regions of the world is described and analyzed in terms of the geographic conditions which have influenced its location and products. Offered in 1970-1971 and in alternate years. 3/4 unit. Roepke.

363. Geography of Minerals. Geographic aspects of the mineral industries. Offered in 1971-1972 and in alternate years. 3/4 unit. Roepke.

365. Geography of Transportation. A consideration of the agents of transportation (land, water, air), the routes of transportation, transportation terminal complexes, and the basic commodity exchange services of transportation within the framework of their regional interregional relationships. 3/4 unit. Booth.

366. Location of Industry and Other Economic Activities: Theory and Practice. Locational theory applied to the relationship between geographic facts of relief, climate, resources, population, and transportation and the industrial location process; case studies in the effects of transportation networks and rates, sources of materials, labor supply, location of markets, etc., on the selection and evaluation of industrial sites; study of factors affecting location of stores and other commercial activities. 3/4 unit. Fellmann, Roepke.

369. Introduction to Human Ecology. Same as Anthropology, Health Education, Physiology, Psychology, Sociology, Veterinary Medical Science, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations and physiological, psychological, and sociological adjustments to environment, regulation of population, and control of the environmental regulating factors. 1/2 or 1 unit. Prerequisite: One year of biology; one year of anthropology, geography, geology, or sociology. Shimkin, Staff.

370. Quantitative Methods in Geography. Geographical applications of statistical and mathematical research techniques. 3/4 unit. Nunnally.

371. Introduction to Research, I. Introductory training in bibliographical and cartographic techniques as source materials of geographic research. 3/4 unit. Prerequisite: Geography major. Fellmann, Jakle, Roseman.

372. Introduction to Research. Continuation of Geography 371. The employment of a range of geographic techniques and sources leading to completion of individual papers. 1/2 unit. Jakle.

373. Map Compilation and Construction. Laboratory instruction and practice in the basic techniques of map making, followed by a consideration of problems involved in the construction of maps for presentation in a reproduced form (i.e., printed, photographed). Included are the selection of proper source materials for the base and body of the map, the compilation and correlation of these materials, and methods of mechanical and photographic reproduction. 1 unit. Foster.

374. Problems in Human Ecology. Same as Anthropology, Health Education, Physiology, Psychology, Sociology, and Veterinary Medical Science 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multidisciplinary studies of selected current problems. 1 unit. Prerequisite: Geog-

raphy, Anthropology, Health Education, Physiology, Sociology, or Zoology 369. ALEXANDER, SHIMKIN.

378. Descriptive Interpretation of Remote Sensors. Descriptive interpretation of remote-sensing images with emphasis on interpretation of aerial photography; applications of aerial photography and photographic interpretation to the solution of problems in the major field of the individual student. Two half-day field trips on Saturdays are required. 1 unit. NUNNALLY.

381. Russian Culture History and Ethnology. Same as Anthropology 381. An historical and structural analysis of the development of Russian culture, especially the peasant traditions from Danubian to contemporary times. $\frac{1}{2}$ or 1 unit. SHIMKIN.

382. Siberian Culture History and Ethnology. Same as Anthropology 382. An ecological analysis of historic and present-day Siberian cultures, with comparisons to Arctic America. $\frac{1}{2}$ or 1 unit. SHIMKIN.

383. Urban Geography. The distribution, functions, and internal structure of cities; a geographic analysis and classification of urban centers and their tributary areas. $\frac{3}{4}$ unit. FELLMANN.

386. Political Geography. World patterns of nations in relation to their natural environmental backgrounds: European nations; Africa, the exploited continent; national structures in Asia; Western Hemisphere nations. $\frac{3}{4}$ unit. GARLAND.

GEOLOGY

Graduate students may take work in the Department of Geology leading to the Master of Science and Doctor of Philosophy. Candidates for the master's degree are advised to plan their work to secure a firm foundation in geology, mathematics, and in chemistry, physics, or biology rather than to specialize too narrowly. Candidates for the doctor's degree may work in the special fields of clay mineralogy, engineering geology and rock mechanics, geochemistry, geophysics, geomorphology and glacial geology, ground-water geology, mineral deposits, mineralogy and petrology, oceanography, paleontology and stratigraphy, sedimentation, sedimentary petrography, structural geology, and submarine geology.

Admission requires a minimum grade-point average of 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

For graduate work in geology a student must have had (or take as a graduate student) undergraduate courses in physical geology, historical geology, mineralogy, petrology, geomorphology or surface processes, structural geology, paleontology, stratigraphy, summer field course, chemistry, physics, and calculus. He may substitute advanced courses in mathematics, chemistry, physics, or the biological sciences for certain geology courses with departmental approval.

A candidate for the doctor's degree may select a minor in chemistry, physics, mathematics, mining or civil engineering, zoology, botany, agronomy, or geography. Other minors may be chosen with departmental approval.

Additional information may be secured by writing the Head of the Department.

Master of Science in the Teaching of Earth Science. Candidates for the Master of Science in the Teaching of Earth Science must earn four units in geology; two units in other earth science areas; and two units in education including History and Philosophy of Education 304 and 305 and Educational Psychology 311 and 312.

FACULTY

Professors: F. A. DONATH (Head of Department), A. V. CAROZZI, C. A. CHAPMAN, C. W. COLLINSON, D. U. DEERE, J. C. FRYE, D. L. GRAF, A. F. HAGNER, W. W. HAY, D. M. HENDERSON, R. L. LANGENHEIM, D. J. STANLEY, G. W. WHITE.

Associate Professors: P. A. Domenico, W. H. Johnson, G. deV. Klein, C. J. Mann, F. D. Patton, P. A. Sandberg.
Assistant Professors: D. E. Anderson, T. F. Anderson, D. B. Blake, J. L. Eades, N. Güven, J. T. Holder, V. V. Palciauskas, D. S. Wood.

COURSES FOR GRADUATES

402. Advanced Historical Geology. Principles of interpretation and problems of earth history. 1 unit.

409. Sedimentation. 1 unit.

415. Regional Field Geology. Field study of critical localities within a geologic province during a period of two or three weeks; discussion of observations and preparation of reports in which the concepts and principles mastered in graduate study are applied to regional geologic synthesis. 1 unit. Prerequisite: Consent of instructor. Staff.

420. Paleoecology. Interpretation of life habit of fossil organisms from skeletal morphology and associated depositional features; reconstruction of marine ecosystem relations from the study of assemblages of fossils. 1 unit. Prerequisite: Geology 320 or equivalent. Hay.

421. Advanced Invertebrate Paleontology. Intensive study of a selected invertebrate group. 1 unit. Prerequisite: Geology or Zoology 320. Blake.

422. Stratigraphic Geology: Paleozoic. The concept of the Paleozoic Era and its periods, series, stages, and zones; evaluation of the type sequences and the succession of faunas; problems of correlation and historical inference. 1 unit. Prerequisite: Geology 321 and 322. Langenheim.

423. Stratigraphic Geology: Mesozoic. The concept of the Mesozoic Era and its periods, series, stages, and zones; evaluation of the type sequences and the succession of faunas; problems of correlation and historical inference. 1 unit. Prerequisite: Geology 321 and 322. Mann.

424. Stratigraphic Geology: Cenozoic. The concept of the Cenozoic Era and its periods, series, stages, and zones; evaluation of the type sequences and the succession of faunas; problems of correlation and historical inference. 1 unit. Prerequisite: Geology 321 and 322.

425. Micropaleontology: Benthonic Foraminifera. Classification, biology, and distribution in time and space of benthonic foraminifera: emphasis on ecology and evolution. 1 unit. Prerequisite: Geology or Zoology 320 or Zoology 318. Hay.

426. Micropaleontology: Ostracoda. Morphology, classification, ontogeny, and phylogeny of fossil and living Ostracoda; study of stratigraphic, paleoecologic, and ecologic distribution, and of soft part morphology. 1 unit. Prerequisite: Geology or Zoology 320. Sandberg.

427. Micropaleontology: Conodonts. Morphology and history of conodonts, chitinozoans, and lesser groups with emphasis on use in biostratigraphy and paleogeography. 1 unit. Prerequisite: Geology or Zoology 320; consent of instructor. Collinson.

428. Micropaleontology: Plankton. Classification and distribution of major groups of shelled oceanic plankton; foraminifera, radiolaria, coccolithophores, diatoms, and others; emphasis is on biostratigraphic use of these fossils. 1 unit. Prerequisite: Geology or Zoology 320 or Zoology 318; consent of instructor. Hay.

430. Crystallography. A consideration of the approaches and techniques required for an understanding of the structures and properties of crystals, especially those of minerals; emphasis is given to the development of pattern theory, space groups, and their applications. 1 unit. Prerequisite: Geology 335 or equivalent; consent of instructor. Henderson.

431. Structural Mineralogy. Principles of the crystal chemistry and structural classification of minerals, and survey of the current knowledge about the structures and structurally

dependent properties and behavior of representative minerals and mineral groups. 1 unit. Prerequisite: Geology 430; consent of instructor. GÜVEN, HENDERSON

432. Sedimentary Geochemistry. Equilibrium assemblages among the principal organic and inorganic sedimentary solids and their associated liquids during weathering, deposition, and diagenesis; kinetics and mechanism of phase changes; transport processes during diagenesis. 1 unit. Prerequisite: Geology 360 or equivalent, or consent of instructor; some background in physical chemistry desirable. GRAF.

433. X-ray Mineralogy. Introduction to the principles and methods of x-ray analysis of polycrystalline mineral phases. 1 unit. Prerequisite: Consent of instructor. GÜVEN.

434. Theoretical Petrology. Use of thermodynamic and kinetic arguments in the solution of basic petrological problems. 1 unit. Prerequisite: Consent of instructor. D. E. ANDERSON.

435. Igneous Petrology. The origin and history of igneous rocks. Application of chemistry and physics to igneous petrology. In the laboratory, a study is made of selected rock suites, and special methods of petrographical investigation are covered. 1 unit. CHAPMAN.

436. Metamorphic Petrology. Problems in metamorphism and advanced studies of metamorphic rocks. In the laboratory, selected rock suites are studied, and special methods of investigation are covered. 1 unit. D. E. ANDERSON.

437. Sedimentary Petrology. A study of sedimentary petrogenesis, including erosion, transportation, deposition, consolidation, diagenesis, and lithification. 1 unit. Prerequisite: Geology 335. KLEIN.

438. Sedimentary Petrography. Microscopic study of sedimentary rocks in thin section with emphasis on textures and structures as a basis for their detailed classification and genetic interpretation. 1 unit. Prerequisite: Geology 335 and 437. CAROZZI.

440. Mineragraphy. Microscopic study of ore minerals including methods of identification, textures, structures, and paragenesis. 1 unit. HAGNER.

443. Mineral Deposits. Principles of mineral deposition and genesis of mineral deposits. 1 unit. Prerequisite: Geology 311. HAGNER.

444. Mineral Deposits. Structural control of mineral deposition and a study of the principal types of mineral deposits. Laboratory study of structures and of types of deposits. 1 unit. Prerequisite: Geology 443. HAGNER.

450. Principles of Engineering Geology. Study of the effects that lithology, weathering, joints, faults, and groundwater have upon engineering projects. The origin, exploration, description, analysis, and significance of geologic factors are studied and illustrated with case histories. A three-day field trip is an integral part of the course. 1 unit. Prerequisite: Geology 250 or equivalent, or consent of instructor. DEERE, PATTON.

451. Practice of Engineering Geology. A study of current and past case histories that illustrate the applications of the principles of engineering geology. These studies include those where lithology, weathering, joints, faults, and groundwater have influenced the exploration, design, construction, and maintenance phases of engineering projects. A three- or four-day field trip to visit engineering construction projects is an integral part of the course. 1 unit. Prerequisite: Geology 450 and Civil Engineering 383, or consent of instructor. DEERE, PATTON.

455. Hydrogeology. The geology of the occurrence, storage, movement, and quality of water in the rocks of the Earth's crust. 1 unit. Prerequisite: Consent of instructor. DOMENICO.

456. Advanced Hydrogeology. Geologic aspects of regional flow and ground water development with emphasis on geologic description and modeling of ground water systems. 1 unit. Prerequisite: Geology 455. DOMENICO.

461. Mineralogy of Clays. Same as Ceramic Engineering 461. The composition of various types of clays; the structure and properties of the clay minerals; the origin and mode of occurrence of the clay minerals and clay materials. 1 unit. Prerequisite: Geology 336 or equivalent; consent of instructor. EADES, GÜVEN.

462. Mineralogy of Clays. Same as Ceramic Engineering 462. The properties of clay materials, their relation to the structure of the clay minerals, methods of determination and control; the utilization of clays in various arts and industries. 1 unit. Prerequisite: Geology 461. EADES.

471. Submarine Geology. General geology of the ocean basins and continental margins, with emphasis on the geological interpretation of marine geophysical investigations. 1 unit. Prerequisite: One year of physics or consent of instructor.

477. Marine Geotechnique. Origin and distribution of deep-sea sediments, theory and methods of sampling, mass physical and chemical properties, structural changes caused by organisms, influence of shear strength, and consolidation on diagenesis. $\frac{1}{2}$ or 1 unit. Prerequisite: Geology 437 or consent of instructor.

479. Statistical Geology. Analysis of the geologic assumptions necessary to fulfill mathematical requirements in numerical analysis of geologic problems. 1 unit. Prerequisite: Mathematics 161 or Agronomy 340; Computer Science 101; consent of instructor. MANN.

488. Advanced Structural Geology. Analysis of geologic deformation based upon the principles of mechanics and utilizing research data from laboratory and field investigations; methods in structural analysis. 1 unit. Prerequisite: Geology 311 or consent of instructor. DONATH, WOOD.

489. Geotectonics. Nature and distribution of major earth structures and geological and geophysical evidence bearing on their origin. 1 unit. Prerequisite: Geology 311 or consent of instructor. WOOD.

493. Advanced Studies in Geology. $\frac{1}{2}$ to 2 units. Work may be taken in the following fields:

(a) **Clay Mineralogy.** EADES, GÜVEN.
(b) **Engineering Geology.** DEERE, PATTON.
(c) **Geomorphology and Glacial Geology.** FRYE, JOHNSON, WHITE.
(d) **Geotectonics.** CAROZZI, WOOD.
(e) **Ground-Water Geology.** DOMENICO.
(f) **Micropaleontology.** COLLINSON, HAY, SANDBERG.
(g) **Mineral Deposits.** HAGNER.
(h) **Mineralogy and Crystallography.** GÜVEN, HENDERSON.
(i) **Paleontology.** BLAKE, HAY, LANGENHEIM, SANDBERG.
(j) **Geochemistry.** T. F. ANDERSON, GRAF.
(k) **Geophysics.** DONATH, HOLDER, PALCIAUSKAS.
(l) **Petrography and Petrology.** D. E. ANDERSON, CHAPMAN.
(m) **Sedimentology.** CAROZZI, KLEIN, STANLEY.
(n) **Stratigraphy.** LANGENHEIM, MANN.
(o) **Oceanography.** HAY, KLEIN, STANLEY.
(p) **Submarine Geology.** KLEIN, STANLEY.
(q) **Structural Geology.** DONATH, WOOD.

499. Thesis Research. Individual work under supervision of members of the staff in their respective fields. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Geomorphology. The study of the history, origin, and characteristics of land forms produced by fluvial, glacial, wind, and wave erosion, or by a combination of these, acting upon the major kinds of geologic materials and structures. Lectures, laboratory, and field trips. 1 unit. Prerequisite: Geology 102. JOHNSON, WHITE.

303. History of Geology. The development of the fundamental concepts of the geological sciences from classical to modern times. 1 unit. Prerequisite: Geology 102 or consent of instructor. CAROZZI.

307. Advanced Dynamic Geology. A study of geologic processes and their effects. 1 unit. Prerequisite: Geology 102 or consent of instructor.

311. Structural Geology. Rock deformation and its results. Lectures, laboratory, and one two-day field trip. 1 unit. Prerequisite: Geology 102, General Engineering 205, or consent of instructor. Wood.

315. Advanced Field Methods. Mapping a structurally and/or stratigraphically significant area of moderate size and difficulty. Preparation of a report. ½ to 2 units. Prerequisite: Geology 215. Staff.

320. Invertebrate Paleontology. Fossil groups in the biological sequence. Lectures and laboratory. Students may not receive credit for both Geology 222 and 320. 1 unit. Prerequisite: Geology 102. Blake, Sandberg.

321. Principles of Stratigraphy. Definition of stratigraphic units, correlation, facies, paleogeography, and historical inference; techniques of physical stratigraphy. 1 unit. Prerequisite: Geology 102. Langenheim, Mann.

322. Stratigraphic Paleontology. Faunal sequences in time and their use in rock correlation. 1 unit. Prerequisite: Geology 320 and 321, or consent of instructor. Blake.

324. Vertebrate Paleontology. Same as Zoology 324. Phylogeny, morphology, and ecology of the fossil vertebrates. Lecture, laboratory, and field trips. Offered in 1971-1972 and in alternate years. ½ unit. Prerequisite: Geology 102 or Zoology 132.

325. Paleobotany. Same as Botany 325. The structure, phylogeny, and geological distribution of representative fossil plants. Two or three field trips. 1 unit. Prerequisite: Botany 100 or Biology 100 and 101, and Geology 101; or consent of instructor.

331. Mineralogy. Introduction to the nature, behavior, geological occurrence, and identification of the solid phases composing the planet Earth. Emphasis on non-silicate minerals. Credit is not allowed for both Geology 331 and 233. 1 unit. Prerequisite: Geology 102; credit or registration in Chemistry 102 or 108. Henderson.

332. Mineralogy-Petrology. Continuation of Geology 331. Emphasis on silicate minerals and rocks. 1 unit. Prerequisite: Geology 331. D. E. Anderson.

335. Optical Mineralogy. Study of the optical properties of minerals and the use of the petrographic microscope. Emphasis is placed on the identification of minerals by the immersion method. Designed for students in geology, ceramics, chemistry, mining, and agriculture. 1 unit. Prerequisite: Geology 332. Chapman, Henderson.

336. Petrography. Study of the constituents, composition, textures, structures, and classification of rocks. In the laboratory, rocks are studied in hand specimen and thin section. Emphasis is placed on the ordinary methods of petrographical investigation. 1 unit. Prerequisite: Geology 335. Chapman.

350. Theoretical Geophysics. An introduction to the major fields of theoretical geophysics: figure of the earth, thermodynamics of the earth, gravity, seismology, magnetism, and planetary geophysics. 1 unit. Prerequisite: Mathematics through calculus; one year of physics; Geology 311; consent of instructor.

351. Geophysical Prospecting. Same as Mining Engineering 351. Principles of geophysics and their application to mining processes. ¾ or 1 unit. Prerequisite: Consent of instructor. de Witte.

357. Glacial and Pleistocene Geology. Consideration of glacial flow, erosion, and deposition; stratigraphic analysis of glacial deposits and correlation of Pleistocene glacial successions with non-glacial sediments. 1 unit. Prerequisite: Consent of instructor. Johnson, White.

360. Chemistry of the Earth. Study of geochemical processes; origin and distribution of elements and isotopes in rocks, sediments, and natural waters. ¾ unit. Prerequisite: Geology 332. T. F. Anderson.

370. Oceanography. Principles of biological, chemical, geological, and physical marine science. 1 unit. Prerequisite: Botany 100 or Zoology 104; Chemistry 101, Geology 101, and Physics 101; or consent of instructor. Hay, Staff.

GERMANIC LANGUAGES AND LITERATURES

(Including German, Germanic, and Scandinavian)

The Department of Germanic Languages and Literatures offers work leading to the Master of Arts and Doctor of Philosophy. Students applying for admission must have a 4.0 grade-point average. Applications of students with grade-point averages below 4.0 but above 3.5 are considered on an individual basis. Students should have completed a four-year course of undergraduate study in German corresponding to that of this University. They should be familiar with the principal works of German literature and be able to follow lectures in the German language. Acquaintance with German history, philosophy, and art in their relation to the general European background is desirable.

Candidates for the Master of Arts in the Teaching of German must earn four units in German, two units in education, and two units in electives. Requirements are: German, two or two and one-half units to be chosen from German 301, 302, 305, 311, 312, 320, 331, 332, 392, 415, or 420; one and one-half to two units from German courses open only to graduates; education, two units, including two of the following courses: History and Philosophy of Education 303, 304, 305, one unit; and Educational Psychology 311 and 312, one unit. The electives must be selected with the approval of the adviser. See pages 36 and 37.

Fields of concentration for the Ph.D. degree are Germanic linguistics, older German literature, modern German literature, and Scandinavian languages and literature.

Detailed information concerning the requirements for advanced degrees in German (the Master of Arts, the Master of Arts in the Teaching of German, and the Doctor of Philosophy) are available at the departmental office and will be sent with application forms to prospective students.

FACULTY

Professors: H. G. Haile (Head of Department), J. R. Frey, J. W. Marchand, P. M. Mitchell, H. Stegemeier.

Associate Professors: E. Antonsen, H. Knust, Ruth E. Lorbe, R. D. Schier.

Assistant Professors: Marianne Burkhard, C. Gray, J. McGlathery, Pauline S. Schwalbe.

German

COURSES FOR GRADUATES

400. Beginning German for Graduate Students. Introduction to the reading of German texts in the sciences and the humanities. 4 semester hours. No graduate credit. Schwalbe.

401. Readings in German for Graduate Students. Designed for graduate students preparing for the German reading requirements for the Ph.D. No graduate credit. Prerequisite: German 400 or equivalent. Schwalbe.

411. Proseminar. Methods of literary criticism and research. 1 unit. Haile.

412. Proseminar. Methods in German language study. 1 unit. Prerequisite: German 365 or equivalent. Antonsen.

415. Middle High German. 1 unit. Prerequisite: German 365. Gray.

416. Middle High German Literature. 1 unit. Prerequisite: German 415 or equivalent. Gray.

420. History of the German Language. 1 unit. Prerequisite: German 365. Antonsen.

431. German Literature of the Middle Ages. German literature from 800 to 1400. Offered in 1971-1972 and in alternate years. 1 unit. Marchand.

432. German Literature from 1400 to 1700. Renaissance, Reformation, and Baroque in German literature. Lectures and readings. Offered in 1971-1972 and in alternate years. 1 unit. Stegemeier.

441. German Romanticism. Offered in 1971-1972 and in alternate years. 1 unit. McGlathery.

442. Nineteenth-Century German Realism. Offered in 1971-1972 and in alternate years. 1 unit. Prerequisite: German 301 and 302, or equivalent.

445. Old High German. Grammar and interpretation of the oldest literary documents. Offered in 1970 1971 and in alternate years. 1 unit. Prerequisite: German 365. Antonsen, Rauch.

447. Old Saxon. Synchronic-diachronic treatment of the language of the *Heliand* and *Genesis;* the position of Old Saxon in the Germanic languages with particular reference to Old High German and Old English. 1 unit. Prerequisite: German 445 or English 401. Rauch.

451. Naturalism, Symbolism, Expressionism. German literature from the 1880's to the 1920's. 1 unit.

452. German Literature from the Twenties to the Present. Offered in 1970-1971 and in alternate years. 1 unit. Prerequisite: German 301 and 302, or equivalent.

460. Seminar in Older German Literature. 1 unit. Prerequisite: German 411 and 495. Staff.

461. Seminar in Modern German Literature. 1 unit. Prerequisite: German 411 and 495. Staff.

493. Research in Special Topics. $\frac{1}{4}$ to 2 units; may be repeated for a maximum of 2 units.

495. Bibliography and Methods of Literary History. To be taken concurrently with German 411. $\frac{1}{2}$ unit. Frey.

499. Thesis Research. 0 to 4 units. Antonsen, Frey, Haile, Marchand, Mitchell, Stegemeier.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. German Literature to 1700. $\frac{3}{4}$ unit. Prerequisite: German 210 and one other course in German literature. Stegemeier.

302. German Literature Since 1700. $\frac{3}{4}$ unit. Prerequisite: German 210 and one other course in German literature. Frey.

303. Advanced Conversation, Composition, and Syntax. Extensive study of advanced problems of grammar, syntax, and style. $\frac{1}{2}$ unit. Prerequisite: Three years of college German including German 212, or consent of instructor.

304. Advanced Conversation. Practice in free conversation with native speaker. No graduate credit. Prerequisite: German 303 or equivalent.

305. Modern German Poetry. A poetical and metrical survey of modern German lyric verse. $\frac{3}{4}$ unit. Prerequisite: German 210 and one other literature course or its equivalent, or consent of instructor. Lorbe.

306. Contemporary German Poetry. A poetical and metrical survey of contemporary German lyric verse. $\frac{3}{4}$ unit. Prerequisite: German 305 or consent of instructor. Lorbe.

311. Goethe. Introduction to Goethe's life and works. Offered in 1970-1971 and in alternate years. $\frac{3}{4}$ unit. Prerequisite: German 210 and one other course in German literature. Haile, Mitchell.

312. Goethe's Faust. Intensive study of Goethe's *Faust*, Parts I and II. Offered in 1970-1971 and in alternate years. $\frac{3}{4}$ unit. Prerequisite: German 210 and one other course in German literature. Haile.

320. History of German Civilization. A selected topical, historical, and pictorial analysis

of German culture and civilization. ¾ unit. Prerequisite: German 210 and one other course in German literature. STEGEMEIER.

331. The Age of Lessing. Offered in 1971-1972 and in alternate years. ¾ unit. Prerequisite: German 210 and one other course in German literature. SCHWALBE.

332. Schiller. Offered in 1971-1972 and in alternate years. ¾ unit. Prerequisite: German 210 and one other course in German literature. FREY.

365. German Phonology and Morphology. Introductory survey of the phonological and morphological structure of the German language. ¾ unit. Prerequisite: Three years of college German or equivalent. ANTONSEN.

366. German Syntax. The structure of the German sentence; historical development; and contrast with English. ¾ unit. Prerequisite: German 365 or consent of instructor. RAUCH.

382. Language Laboratory Techniques. Same as French, Russian, and Spanish 382. Instruction and practice in the techniques of making foreign-language tapes and integrating them with classroom activity; instruction in the problems of planning and operating a language laboratory. ½ unit. Prerequisite: Three years of a modern foreign language at the college level, or equivalent. MEYER.

392. Topics in German Literature. Intensive study of individual authors or other restricted topics in German literature. 1 unit. Prerequisite: Two advanced courses in German literature.

394. Introduction to Folklore: History, Theory, Methods. Same as Comparative Literature, English, and Slavic 394, and Speech 346. An introduction to the study of folklore with emphasis on folk cultures in the Old and New World; an historical survey of the development of folklore study, an analysis of the methods and genres of folklore, and an introduction to field collecting and evaluation of archival materials. ¾ unit. Prerequisite: A reading knowledge of one modern foreign language is recommended.

Germanic

COURSES FOR GRADUATES

426. Gothic. An introduction to Germanic (comparative) linguistics. Offered in 1971-1972 and in alternate years. 1 unit. Prerequisite: Germanic 367 or consent of instructor. ANTONSEN.

462. Seminar in Germanic Philology and Linguistics. Problems in diachronic and descriptive Germanic linguistics. 1 to 2 units. Prerequisite: Consent of instructor. ANTONSEN, RAUCH.

465. Comparative Germanic Phonology and Morphology. The reconstruction of the phonological and morphological systems of Proto-Germanic and their development into the Germanic languages and dialects. Offered in 1971-1972 and in alternate years. 1 unit. Prerequisite: Germanic 426 or consent of instructor. ANTONSEN, RAUCH.

467. Runology. A detailed analysis of inscriptions in the "older" Germanic futhark, the Anglo-Frisian futhorc, and the Scandinavian "younger" futharks; their relationships and the correlation between phonological and orthographic developments. Offered in 1970-1971 and in alternate years. 1 unit. Prerequisite: Germanic 465 or consent of instructor. ANTONSEN.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

367. Introduction to Germanic Linguistics. Same as Linguistics 367. A comparative and historical survey of the Germanic languages. ½ unit. Prerequisite: Completion of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. Some knowledge of German desirable. ANTONSEN.

Scandinavian

COURSES FOR GRADUATES

405. Old Norse-Icelandic, I. Grammar and selected readings. Offered in 1971-1972 and in alternate years. 1 unit. MITCHELL.

406. Old Norse-Icelandic, II. Readings. Selections from the Elder Edda and the sagas. Offered in 1971-1972 and in alternate years. 1 unit. Prerequisite: Scandinavian 405. MARCHAND.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

361. Ibsen. The dramas in English translation; selected works of Ibsen's Scandinavian contemporaries. Offered in 1971-1972 and in alternate years. 1 unit. MITCHELL.

362. Strindberg and the Later Scandinavian Dramatists. Major dramas and prose works of August Strindberg in translation; selected plays by Kaj Munk, Kjeld Abell, Nordahl Grieg, and Pär Lagerkvist. Offered in 1970-1971 and in alternate years. 1 unit. MITCHELL.

GOVERNMENT AND PUBLIC AFFAIRS

The Institute of Government and Public Affairs renders advisory, consulting, and research services to the governments of Illinois and their elected and appointed officials. Using the data acquired in these activities, the staff seeks, through scholarly and popular publication, to advance knowledge about the science of government and the political process.

GREEK

See description and course listings under Classics, page 135.

HEALTH AND SAFETY EDUCATION

The Department of Health and Safety Education offers a program of study leading to the Master of Science in Health Education. (For information regarding the degree of Doctor of Philosophy in Physical Education with specialization in health education, see page .) This program is centered in preparing teachers, administrators, and research workers in the general field of school health education, but also offers opportunities for preparation in the special fields of community health education and safety education.

Admission requirements for a major in this field are: (1) a grade-point average of 3.75 (although applications of students with averages below 3.75 but above 3.5 may be considered on an individual basis); (2) thirty semester hours of approved undergraduate credit in health education or closely related courses; (3) twenty-four semester hours of approved undergraduate credit in science; (4) sixteen semester hours of credit in education; and (5) a course in statistics or measurement.

Requirements for the master's degree are eight units to include: (1) four units in health education, one unit of which may be in approved courses in physical education or recreation; (2) two units in education: History and Philosophy of Education 304 and 305, and Educational Psychology 311 and 312; (3) satisfactory completion of Health Education 490, no credit; (4) presentation of an acceptable thesis in health education, two units. Candidates may petition to waive the thesis and seminar requirements but will be required to take two units in lieu of thesis credit and, in addition, to pass a final comprehensive written examination in health education. See pages 36 and 37.

FACULTY

Professors: H. S. Hoyman (Head of Department), W. H. Creswell, Jr., A. E. Florio, W. J. Huffman.
Associate Professor: D. B. Stone.
Lecturer: C. A. Bridger.

Health Education

COURSES FOR GRADUATES

400. Scientific Foundations of Health Education. Designed to reinforce and extend the student's knowledge of pertinent scientific health facts and principles as these apply to the further improvement of personal, family, and community health. 1 unit. Prerequisite: Undergraduate courses beyond the elementary level in the biological and physical sciences and in health education. Hoyman.

401. Problems in School Health Education. History, philosophy, principles, and practices of school health education in its three main phases: health service, healthful school environment, and health instruction, including evaluation. 1 unit. Creswell, Hoyman, Huffman, Olsen.

403. Problems in Public Health. Deals with the basic facts and principles of public health at the local, state, and national levels, including the relationships between public health departments, voluntary health agencies, and the school health program. $\frac{1}{2}$ or 1 unit. Olsen, Stone.

404. Trends and Issues in Sex Education. A critical analysis of current trends and basic issues of sex education; study of present status of sex education in the United States and selected foreign countries; a critical analysis of philosophy, principles, methods, and current problems. 1 unit. Prerequisite: Undergraduate courses beyond the elementary level in the biological and social sciences, Health Education 285 or equivalent, or consent of instructor. Creswell, Hoyman, Huffman.

490. Seminar. Student presentation of thesis reports in health and safety education; informal discussions, lectures, and critical analysis of current problems in health and safety education. No credit. Prerequisite: Health Education 495. Staff.

493. Special Projects. Independent research. Open only to candidates for the Doctor of Philosophy. $\frac{1}{2}$ or 1 unit. Prerequisite: Educational Psychology 390, Physical Education 495, and Health Education 400, or equivalent. Staff.

495. Research Methods in Health and Safety Education. Special emphasis on research orientation and methods; experimental design; processing and analysis of data; selection of research problems and preparation of thesis; current research literature in health and safety education. $\frac{1}{2}$ unit. Prerequisite: Educational Psychology 390 or equivalent. Creswell, Huffman.

499. Thesis Research. Preparation of theses in health and safety education. $\frac{1}{2}$ to 2 units. Prerequisite: Health Education 495. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

369. Introduction to Human Ecology. Same as Anthropology, Geography, Physiology, Psychology, Sociology, Veterinary Medical Science, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations and physiological, psychological, and sociological adjustments to environment, regulation of population, and control of the environmental regulating factors. $\frac{1}{2}$ or 1 unit. Prerequisite: One year of biology; one year of anthropology, geography, geology, or sociology. Shimkin, Staff.

374. Problems in Human Ecology. Same as Anthropology, Geography, Physiology, Psychology, Sociology, and Veterinary Medical Science 374. Methodologies for in-

vestigation of problems in human ecology; effects of specific environmental and social factors; multidisciplinary studies of selected current problems. 1 unit. Prerequisite: Anthropology, Geography, Health Education, Physiology, Sociology, or Zoology 369. HOYMAN, LEVINE, STAFF.

390. Public Health Education. Theory and practice of community health education; adult health education through media such as radio, television, films, slides, posters, pamphlets, and newspapers; projects in preparing and using public health education materials; evaluation of research in public health education. ½ unit. Prerequisite: Consent of instructor. OLSEN, STONE.

391. Public Health Statistics. An introduction to public health statistics including collection and classification of data; rates and other indices; measures of central tendency and dispersion; tests of significance; use of vital statistics in planning, conducting, and evaluating public and school health education programs. ½ unit. Prerequisite: Mathematics 161 or Educational Psychology 390, or equivalent. BRIDGER.

392. Health and Safety Education in the Elementary School. An overview of the school health program designed to acquaint the teacher with modern concepts of health and safety education in the elementary school; consideration is given to the role of the classroom teacher in understanding and meeting the health needs of children; the course focuses on the legal requirements for Illinois schools, major health and safety problems of elementary children, the teacher's role in the school health program, and methods and materials in teaching modern health and safety education. ½ unit. Prerequisite: One year of biological science. STONE.

Safety Education

COURSES FOR GRADUATES

402. Problems in Safety Education. Philosophy of safety: traffic, recreation, home, and industrial safety facts and figures; the safety problem and its relation to education; organization of safety education programs; methods of teaching; legal aspects; research problems. 1 unit. FLORIO, HUFFMAN.

HEBREW, MODERN

See descriptions and course listings under Linguistics, page 282.

HINDI

See descriptions and course listings under Linguistics, page 282.

HISTORY

The Department of History offers work leading to the Master of Arts and Doctor of Philosophy degrees. Graduate work in history presupposes two years of undergraduate study in this subject, or a minimum of sixteen semester hours, including courses in European and American history. Undergraduate linguistic preparation, especially in French, German, or Russian, is important. For ancient, medieval, and renaissance history, some knowledge of Greek or Latin is essential. Spanish is useful for certain fields of European, American, and Latin-American history.

Admission to graduate study in history requires a grade-point average of at least 4.0 for the last sixty hours of undergraduate study. A student who has done graduate work in a rec-

ognized institution but without receiving a degree may petition to receive credit toward an advanced degree by passing examinations in this work.

Results of the Graduate Record Examination Aptitude Test should accompany applications for admission to the Graduate College. Information concerning the dates and places for taking this examination may be secured by writing to the Educational Testing Service, Box 955, Nassau Street, Princeton, New Jersey 08540.

Mimeographed material concerning rules in detail is available at the department office.

Master of Arts. Candidates are expected to take at least two units in two of the fields of specialization for the Doctor of Philosophy listed below. A minimum of eight units is required for the Master of Arts and three of these units must be at the 400 level. The program must include two research seminars with grades of B or better. Students may elect to write a master's thesis, but the thesis does not replace the seminar requirement. A candidate must demonstrate ability to read one foreign language related to his fields of interest as approved by the graduate advisers.

Graduate study in history may also be pursued in connection with the Master of Arts in the Social Sciences and Master of Arts in the Teaching of Social Studies (see page 360).

Doctor of Philosophy. The Department of History offers the following fields of specialization and preparation: ancient Greece; ancient Rome; medieval to 1300; Europe, 1300-1648 (Renaissance and Reformation); Europe and dependencies, 1648-1815; Europe and dependencies since 1815; Russia; England to 1688; England and the Empire-Commonwealth since 1688; Near East and Middle East; China; Japan; South Asia; early America to 1789; United States since 1789; Latin America; History of Science; East Central Europe or Southeast Europe.

A candidate must demonstrate ability to read two foreign languages related to his fields of interest as approved by the graduate advisers. A student who has not completed the requirement in one language will not be readmitted to a second year of graduate study. No student is recommended for financial aid of any kind for a third year of study who has not fulfilled both language requirements.

Two research seminars are normally required for all candidates if these were not taken here in the master's program. History 496 and 498 also are required. The doctorate requires a minimum of sixteen units beyond the master's degree. Eight of these may be thesis research credit.

Candidates shall offer three fields in history, no more than two in the same area, for their preliminary examination. Although an adviser may require work in departments or areas other than history, such work need not be part of the preliminary examinations. A manual for graduate students in history is available from the department.

Doctoral candidates interested in specializing in American culture may elect a major in American history with a first minor, three units, in American literature, and a second minor, two units, in the history of fine arts in the United States.

Illinois Historical Survey. Graduate students have an opportunity to pursue research in connection with the Illinois Historical Survey, an organization carrying on systematic studies in the history of the Midwest. Through the use of materials collected by this survey, students in history are able to obtain useful training in the study of manuscript as well as printed materials.

FACULTY

Professors: W. U. Solberg (Chairman of Department), W. L. Arnstein, J. L. Bates, P. P. Bernard, C. E. Dawn, W. D. Farnham, R. T. Fisher, Jr., W. Heinrichs, K. A. Hitchins, R. W. Johanssen, J. A. Nichols, D. E. Queller, P. W. Schroeder, C. C. Spence, R. M. Sutton.

Associate Professors: R. B. Crawford, J. R. Dahl, L. E. Eastman, B. D. Hill, F. C. Jaher, B. B. Kling, T. A. Krueger, J. L. Love, R. M. McColley, R. E. Mitchell, J. B. Sirich, R. W. Waller.

Assistant Professors: W. Applebaum, Natalia M. Belting, F. F. Foster, J. P. McKay, D. L. Ransel, D. E. Sumler, R. C. Trexler, T. Unno.

COURSES FOR GRADUATES

403. Problems in European History to 1815. 1 unit. Staff.

404. Problems in Modern European History Since 1815. 1 unit. Staff.

407. Problems in American History to 1865. 1 unit. Staff.

408. Problems in American History Since 1865. 1 unit. Staff.

409. Problems in Asian History. 1 unit. Staff.

411. Seminar in Ancient History: Greece. 1 unit. Mitchell, Starr.

413. Seminar in Ancient History: Rome. 1 unit. Mitchell, Starr.

415. Seminar in Medieval History. 1 unit. Queller.

417. Seminar in Renaissance and Reformation History. 1 unit. Bernard.

419. Seminar in European History, 1648 to 1815. 1 unit. Bernard, Sirich.

421. Seminar in European History Since 1815. 1 unit. Hitchins, McKay, Nichols, Schroeder.

423. Seminar in English History to 1688. 1 unit. Hill.

425. Seminar in English and British Empire History Since 1688. 1 unit. Arnstein.

427. Seminar in Russian History. 1 unit. Fisher, Uroff.

441. Seminar in Near and Middle Eastern History. 1 unit. Dawn.

443. Seminar in South Asian History. 1 unit. Kling.

445. Seminar in East Asian History. 1 unit. Crawford, Eastman.

451. Seminar in Early American History to 1789. 1 unit. Stearns.

453. Seminar in American History Since 1789. 1 unit. Bates, Johannsen, Krueger, McColley, Solberg, Spence, Sutton, Waller.

461. Seminar in Latin-American History. 1 unit. Love.

471. Seminar in the History of Science. 1 unit. Applebaum.

496. History of Historiography. Introduction to the great historians from early times to the present. 1 unit.

497. Reading Course. Directed reading in special fields. Open only to students with a master's degree or equivalent, who are preparing for the preliminary examination in history and who need instruction in areas not provided by current course offerings. 1 unit. Prerequisite: Master's degree or equivalent; consent of instructor. Staff.

498. Problems in the Teaching of College History. No credit. Prerequisite: Candidate for Ph.D. degree in history. Staff.

499. Thesis Research. Individual direction in research and guidance in writing theses for advanced degrees. 0 to 4 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

The general prerequisite for all graduate students registering in 300-numbered courses is one year of college history or consent of instructor.

301. The Middle Ages from 400 to 1100 A.D. Europe from the fall of Rome to the first crusade. ½ or 1 unit. Queller.

302. The Middle Ages from 1100 to 1500 A.D. Europe from the rise of towns to the establishment of national monarchy. ½ or 1 unit. Queller.

303. History of Byzantine Civilization. A study of cultural, religious, and social history

of the Eastern Roman Empire from Constantinople's foundation in 330 A.D. to the fall of Byzantium in 1453. Special attention is given to the continuation of classical ideals and Byzantine relations with the Latin West and the Slavic and Muslim worlds. ½ or 1 unit.

304. **Medieval Civilization.** Religious and intellectual. ½ or 1 unit. Prerequisite: One year of college history or political science. HILL, QUELLER.

305. **The Age of the Renaissance.** ½ or 1 unit. QUELLER, TREXLER.

306. **The Age of the Protestant and Catholic Reformation, 1500 to 1648.** ½ or 1 unit. BERNARD.

307. **Classical Islam: The Near East from Mohammed to the Crusades.** ½ or 1 unit. DAWN.

308. **The Europeanization of the Near East, 1768 to 1914.** ½ or 1 unit. DAWN.

309. **Development of Modern Europe: Absolutism and Colonial Expansion, 1648 to 1789.** ½ or 1 unit. BERNARD, SIRICH.

310. **Development of Modern Europe: The French Revolution and Napoleon, 1789 to 1815.** ½ or 1 unit. SIRICH.

311. **European History from 1815 to 1871.** ½ or 1 unit. Prerequisite: One year of college history, political science, or economics. NICHOLS.

312. **European History from 1871 to 1918.** ½ or 1 unit. Prerequisite: One year of college history, political science, or economics. NICHOLS.

313. **European History from 1918 to 1939.** ½ or 1 unit. Prerequisite: One year of college history, political science, or economics. SUMLER.

314. **European History from 1939 to the Present.** ½ or 1 unit. Prerequisite: One year of college history, political science, or economics. SUMLER.

315. **Economic and Social History of Europe to 1815.** A history and analysis of the development of European economy and society from the Middle Ages to the Industrial Revolution; evolving agrarian systems; growth of commercial economies; industrial and technical progress; colonial expansion. ½ or 1 unit. Prerequisite: One year of college history or economics, or consent of instructor. MCKAY.

316. **Economic and Social History of Europe Since 1815.** A comparative study of the Industrial Revolution in England, France, Germany, and Russia; social, cultural, and demographic consequences of rapid economic change; expanding world economy and modern imperialism. ½ or 1 unit. Prerequisite: One year of college history or economics, or consent of instructor. MCKAY.

317. **Modern Italy, 1815 to the Present.** A survey of Italian political, social, economic, and cultural developments from the aftermath of the Napoleonic wars to the post-Second World War republic. ½ or 1 unit.

318. **Modern European Diplomatic History, 1789 to 1890.** The diplomatic history of Europe from the French Revolution to the fall of Bismarck. ½ or 1 unit. SCHROEDER.

319. **Modern European Diplomatic History, 1890 to the Present.** The diplomatic history of Europe from the fall of Bismarck to the present day. ½ or 1 unit. SCHROEDER.

320. **Russia from the Earliest Times to Peter the Great.** The political, economic, cultural, and social development of Russia during the Kievan and Muscovite periods. ½ or 1 unit. UROFF.

321. **Russia from Peter the Great to 1855.** The political, economic, cultural, diplomatic, and social development of Russia during Imperial times. ½ to 1 unit. RANSEL.

322. **Germany Since 1890.** Germany as a modern industrial society, with emphasis on the breakdown of German constitutionalism and the nature of National Socialism and the totalitarian state. ½ or 1 unit.

323. **Intellectual History of Modern Europe, 1513 to 1770.** A survey of the seminal ideas

in the fields of political, social, and economic thought which have influenced the d velopment of modern Europe. ½ or 1 unit. BERNARD, SIRICH.

324. Intellectual History of Modern Europe, 1770 to the Present. A survey of th seminal ideas in the fields of political, social, and economic thought which have infl enced the development of modern Europe. ½ or 1 unit. BERNARD, SIRICH.

325. Intellectual and Cultural History of Russia to 1881. ½ or 1 unit. UROFF.

326. Intellectual and Cultural History of Russia from 1881 to the Present. ½ or unit. Prerequisite: One year of college history or political science, or consent of instru tor. UROFF.

327. Russia from 1855 to the Bolshevik Revolution of 1917. ½ or 1 unit. FISHER.

328. History of Soviet Russia from 1917 to the Present. ½ or 1 unit. Prerequisit One year of college history or political science, or consent of instructor. FISHER.

329. History of Southeastern Europe, Fourteenth to the Eighteenth Century. Th Byzantine heritage, the Ottoman conquest and its impact upon the peoples of the Balkan and the internal political and cultural history of the Rumanians, South Slavs, Greek and Albanians to 1804. ½ or 1 unit. HITCHINS.

330. History of Southeastern Europe Since 1804. The rise of nationalism and the form tion of national states in the Balkans, the decline of the Ottoman Empire, and th political and cultural history of Rumania, Yugoslavia, Bulgaria, Greece, and Albania the nineteenth and twentieth centuries. ½ or 1 unit. HITCHINS.

332. Medieval England. Religious, social, intellectual, and economic developments medieval England from the period of the Germanic invasions to the accession of th Tudors. ½ or 1 unit. HILL.

333. Great Britain Under the Tudors and Stuarts, 1485 to 1660. The principal politica economic, social, religious, and cultural developments in British history, includi Scotland and Ireland, from the beginning of the Tudor dynasty to the Restoration 1660. ½ or 1 unit. FOSTER.

334. Great Britain Under the Later Stuarts and the Hanoverians, 1660 to 1815. Th principal political, economic, social, religious, and cultural developments in Britis history from the Restoration to the end of the Napoleonic wars. ½ or 1 unit.

337. Economic History of American Agriculture. Same as Agricultural Economics an Economics 337. The development of American agriculture from early colonial times the present. Emphasis on regional development, evolution of methods and equipmen trends in marketing and credit, and the making of federal farm policy ¾ or 1 uni Prerequisite: A college-level course in basic economics or American history. GUITHER.

338. History of Cosmology. A history of man's changing conceptions of the structure an origin of the universe from the ancient creation myths to modern times. The relationshi between cosmological theories and developments in the physical sciences, philosoph religion, and social and cultural factors are explored. ½ or 1 unit. Prerequisite: One ye of college history or philosophy, or consent of instructor. APPLEBAUM.

339. History of the British Commonwealth in the Nineteenth Century, 1783 to 190 ½ or 1 unit. ARNSTEIN.

340. History of the British Commonwealth in the Twentieth Century, 1901 to th Present. ½ or 1 unit. ARNSTEIN.

341. Modern Britain: The Victorian Era, 1815 to 1900. A history of the political, co stitutional, social, economic, and diplomatic developments of the United Kingdon including Ireland. ½ or 1 unit. ARNSTEIN.

342. Modern Britain Since 1900. A history of the political, constitutional, social, economi and diplomatic developments of the United Kingdom, including Ireland. ½ or 1 uni ARNSTEIN.

343. History of Spain and Portugal. A survey of the Iberian Peninsula from the earliest historical times to the present. ½ or 1 unit. Prerequisite: One course in college history.

345. Constitutional History of England to 1485. Important for those who intend to study law. ½ or 1 unit. Prerequisite: One year of college history or political science. HILL.

346. Constitutional History of England, 1485 to the Present. Important for those who intend to study law. ½ or 1 unit. Prerequisite: One year of college history or political science. HILL.

349. The Scientific Revolution, 1543 to 1727. A study of the birth of modern science in the seventeenth century, with special emphasis upon the rise of experimentalism, the growth of mathematical science, and the establishment of the mechanical philosophy. ½ or 1 unit. APPLEBAUM.

350. History of American Immigration to 1880. The migrations which peopled the English colonies and the United States and their role in the shaping of American society and culture. ½ or 1 unit. Prerequisite: One year of college history or consent of instructor.

351. History of American Immigration Since 1880. Late nineteenth- and early twentieth-century migrations and their impact on American society and culture. ½ or 1 unit. Prerequisite: One year of college history or consent of instructor.

352. Colonial Beginnings of American Life and Institutions. A study of the seventeenth- and eighteenth-century colonies. ½ or 1 unit.

353. American Negro History. Negroes in America from the development of the slave trade through emancipation and up to the present; emphasis is on the fifteenth- to seventeenth-century origins of modern slavery; some attention is given to slavery and emancipation throughout the Western hemisphere. ½ or 1 unit. MCCOLLEY.

354. The Era of the American Revolution, 1763 to 1789. ½ or 1 unit.

355. Federalists, Jeffersonians, and the Era of Good Feelings. United States history from 1789 to 1828 with emphasis on the conflict between nationalism and sectional interests. ½ or 1 unit. MCCOLLEY.

356. History of the United States, Jackson to the Civil War. Study of Jacksonian democracy; the rise of sectionalism; manifest destiny and the Mexican War; the issue of slavery and expansion and the approach of the Civil War. ½ or 1 unit. JOHANNSEN.

357. Economic History of the United States, 1775 to 1860. The growth of American economic life and institutions from the Revolution to the outbreak of the Civil War. ½ or 1 unit. SPENCE.

358. Economic History of the United States Since 1860. The growth of American economic life and institutions since 1860. ½ or 1 unit. SPENCE.

359. The Civil War and Reconstruction. Remote and immediate causes of the Civil War, especially from 1850 to 1861; problems of the North and South during the war; the consequences of the war; the efforts to create a new Union, 1865 to 1877, and the new problems created by those efforts. ½ or 1 unit. JOHANNSEN.

360. History of the United States, 1877 to 1909. ½ or 1 unit. Prerequisite: One year of college history, political science, or economics. BATES.

361. History of the United States, 1909 to 1932. ½ or 1 unit. Prerequisite: One year of college history, political science, or economics. BATES.

362. History of the United States Since 1932. ½ or 1 unit. Prerequisite: One year of college history, political science, or economics. KRUEGER.

363. Social History of Industrial America to 1890. The impact of industrialization, immigration, and urbanization on American society in the nineteenth century. ½ or 1 unit. JAHER.

364. Social History of Industrial America Since 1890. A study of the impact of industrial technology, business enterprise, immigration, and urbanization on American society. ½ or 1 unit. JAHER.

365. The History of Illinois to 1870. Evolution of a typical midwestern commonwealth with emphasis upon its political, economic, social, religious, and cultural developmen in the nineteenth century. ½ unit. SUTTON.

366. The History of Illinois from 1870 to the Present. The evolution of a modern Amer can state, with emphasis upon its political life, economic growth, social and intellectu problems, and its contributions to the American nation. ½ unit. SUTTON.

367. The Trans-Mississippi West. The history of Western expansion since the Louisian Purchase; the West in the general history of the United States; Western economic an political problems. ½ or 1 unit. SPENCE.

368. History of the South. An inquiry into the question, when did the South begin an what have been in distinguishing traits? Special attention is given to agrarianism, in dustrialization, and the race problem. ½ or 1 unit. BATES.

369. Constitutional Development of the United States to 1865. ½ or 1 unit. Prerequisite One year of college history or political science. FARNHAM.

370. Constitutional Development of the United States Since 1865. ½ or 1 unit. Pre requisite: One year of college history or political science. FARNHAM.

371. American Intellectual and Cultural History to 1877. Social and political though religion, science, scholarship, and education as both results and causes of America experience. ½ or 1 unit. SOLBERG.

372. American Intellectual and Cultural History Since 1877. The contribution social and political thought, religion, science, scholarship, and education to the histor of American civilization. ½ or 1 unit. SOLBERG.

373. Diplomatic History of the United States to the End of the Nineteenth Century ½ or 1 unit. Prerequisite: One year of college history or political science. HEINRICHS.

375. History of Latin America to 1824. A survey of Latin-American history from th discovery of America until 1824. ½ or 1 unit.

376. Latin America Since 1824. A history of the Latin-American republics from their in dependence to the present. ½ or 1 unit.

377. History of Modern Brazil from 1808 to the Present. An analysis of developmen from 1808, emphasizing the advances and discontinuities in the growth of a neocolonia agricultural society into an urban, industrial polity. ½ or 1 unit. Prerequisite: One yea of college history or enrollment in Latin-American studies program. LOVE.

378. History of Modern Mexico, 1765 to the Present. The development of Mexico fro the Bourbon reforms of the Enlightenment to the post-revolutionary present, wit emphasis on social, economic, and political change; social science concepts of economi underdevelopment, social integration, and nation-building. ½ or 1 unit. Prerequisite Enrollment in the Latin-American studies program. LOVE.

381. Ancient Greek States. History of the Greek states from the earliest times to 334 B.C ½ or 1 unit.

382. Alexander and His Successors. ½ or 1 unit. MITCHELL.

383. History of the Roman Republic to 44 B.C. ½ or 1 unit. MITCHELL.

384. The Roman Empire. ½ or 1 unit. MITCHELL.

387. Indian History and Civilization to 1707. Development of Indian civilization up t the British conquest. Political evolution; religious and philosophical sytems; society art, and literature during Hindu and Muslim periods. ½ or 1 unit. KLING.

388. Development of Modern India and Pakistan from 1707. Establishment an organization of the British Empire in India; reaction of India to the Western impact growth of nationalism and the struggle for independence. ½ or 1 unit. KLING.

389. Problems of Contemporary South Asia. Current political, economic, social, an cultural problems of India, Pakistan, and Ceylon dealt with in the perspective of th historical development of South Asia. ½ or 1 unit. KLING.

390. China Under the Ch'ing Dynasty. The period of Manchu domination in China (1644 to 1912). Emphasis is on Chinese reactions to Western influences during the nineteenth century. ½ or 1 unit. CRAWFORD.

391. A History of China to 906 A.D. A history of the formative period of the Chinese state, society, and economy. ½ or 1 unit. CRAWFORD.

392. History of China, 907 to 1644. A history of the early modern Chinese state and society prior to the Western impact. ½ or 1 unit. CRAWFORD.

393. Chinese Intellectual History from Earliest Times to the Present. A study of the major ideas and schools of thought as they have affected the course of Chinese history and the development of its institutions. ½ or 1 unit. EASTMAN.

394. Twentieth-Century China. Chinese state and society in revolutionary transition; emphasis on the Nationalist and Communist revolutions and their results. ½ or 1 unit. EASTMAN.

395. Premodern Japan. Japanese history from its origins to 1800; evolution of the traditional society, stressing institutional and cultural problems of the ancient, "feudal," and early modern (Tokugawa) period. ½ or 1 unit. PIERSON.

396. Modern Japan. Japanese history since 1800; institutional and cultural problems connected with Western pressure, the Meiji Restoration, rise and fall of empire, and creation of a modern society. ½ or 1 unit. PIERSON.

397. History and Thought of Japanese Buddhism. The Japanese response to Buddhism and its influence on Japanese life and culture. ½ to 1 unit. Prerequisite: Consent of instructor. UNNO.

398. Intellectual History of Japan. Shinto, Buddhism, Confucianism, and Western thought as cultural and social forces in the evolution of Japan from its origins to the present. ½ or 1 unit. Prerequisite: One year of college history or philosophy. PIERSON.

399. History and Thought of Chinese Buddhism. The interaction of Buddhism with Chinese thought and institutions from its introduction to the present. ½ to 1 unit. Prerequisite: Consent of instructor. UNNO.

HOME ECONOMICS

The Department of Home Economics offers work leading to the Master of Science or Master of Arts in Home Economics; Master of Science in Home Economics Education; and Doctor of Philosophy in Home Economics with majors in family and consumption economics and in foods and nutrition. The major work for a master's degree in home economics may be done in one of six curricula as shown below. The minimum grade-point average for admission to graduate study in home economics and home economics education is 3.75. Applications of students with averages below 3.75 but above 3.5 are considered on an individual basis.

Master of Science or Master of Arts. Candidates for a master's degree in home economics must complete a minimum of eight units (nine if a thesis is not submitted), of which at least four must be in home economics. Four of the total units, including at least two in home economics, must be in 400-level courses.

Lists of suggested electives for each curriculum are available from the department upon request. Required courses for each of the six curricula are given below:

(1) *Child Development and Family Relationships.* A minimum of four units from Home Economics 301, 410, 418, 419, and 493 or 499.

(2) *Family and Consumption Economics.* A minimum of four units from Home Economics 313, 370, 379, 470, 499, with credit in Home Economics 370 and 499 required. A minimum of two units from Economics 300, 301, 400-401, or 402-403.

(3) *Family Housing and Household Management.* A minimum of nine units: two from Home Economics 361, 370, 375, 378, 379, and 470; Agricultural Mechanization 300, and Architecture 339; three units from Home Economics 380, 410, 418, 419, 480, 487, and 493; two units from Economics 313, Finance 369, Sociology 407, 476, 477.

(4) *Foods and Nutrition.* A minimum of four units from Home Economics 320, 322, 324, 330, 331, 422, 423, 430, 432, and 499; also, Biochemistry 354, or 350 and 355 are required.

(5) *General Home Economics.* A minimum of four units from prescribed courses in three of the other five curricula in home economics.

(6) *Textiles and Clothing.* A minimum of four units from Home Economics 375, 380, 386, 388, 395, 480, 487, 493, and 499.

Candidates for the Master of Science in Home Economics Education must earn eight units, four of them in home economics. Three of the eight units must be in 400-numbered courses and at least one of these must be in home economics. Courses in home economics are to be chosen from Home Economics 301, 320, 322, 323, 326, 330, 331, 361, 375, 378, 379, 380, 386, 388, 395, 410, 418, 419, 480, and 487; Educational Psychology 311 and 312, one unit; two of the following courses: History and Philosophy of Education 301, 302, 303, 304, one unit; Vocational and Technical Education 453, one unit; Vocational and Technical Education 456, one unit, or Home Economics 377, one-half to one unit. See pages 36 and 37.

Doctor of Philosophy. Candidates for this degree may specialize in (1) family and consumption economics or (2) foods and nutrition.

A student entering the first year of graduate study with emphasis in family and consumption economics should have had a total of fifteen hours in anthropology, economics, psychology, and sociology. Deficiency in this requirement may be made up during the first year of graduate study. Required courses include four units of family and consumption economics, two at the 400 level; two units of economic theory (400 level); two additional units of economics and/or agricultural economics (400 level); two units of anthropology, psychology, and/or sociology or one unit in these areas and Home Economics 410; and one unit of applied statistics. Additional units to bring the total to twenty-four units, of which eight must be doctoral dissertation units. Economics must be chosen as a minor field either as a sole minor or in combination with an area such as agricultural economics, anthropology, sociology, closely related areas in home economics, or an area involving international programs. A student not having an undergraduate degree in home economics will be expected to take the second minor in a closely related area in home economics.

Candidates for the degree with emphasis in foods and nutrition must present an undergraduate foods course with an organic chemistry prerequisite; a nutrition course with organic chemistry and physiology prerequisites; adequate training in chemistry, including quantitative analysis and organic; and introductory courses in microbiology, physics, and trigonometry. A student emphasizing foods in the doctoral program should have had a course in colloid chemistry. Deficiencies in these requirements may be made up during the first year of graduate study.

Required courses include at least three units of foods and nutrition, two at the 400 level; one unit of statistical methods at the 400 level; courses in biochemistry and physical chemistry; and an advanced course in food microbiology or mammalian physiology. Additional courses in the above areas or in animal nutrition or food science are selected to satisfy major unit requirements. Candidates may minor in animal nutrition, biochemistry, food science, microbiology, physiology, and other appropriate areas. Either foods or nutrition is emphasized in research for the thesis.

Graduate students who choose an area of home economics as a minor for the Doctor of Philosophy must complete three units for a first minor or two units for a second minor in addition to credit offered for the master's degree. At least one unit must be taken in 400-level courses.

FACULTY

Professors: Janice M. Smith (Head of Department), Marilyn M. Dunsing, Ruth L. Galbraith, Queenie B. Mills, Lorraine D. Trebilcock, Frances O. Van Duyne.

Associate Professors: Karlyne A. Anspach, Esther L. Brown, Margaret Goodyear, Betty E. Haskell, Beulah Hunzicker, Willie Mae Mowrer.

Assistant Professors: M. J. Sporakowski, L. D. Van den Daele, Beula V. McKey.

COURSES FOR GRADUATES

410. Problems in Family Living. Family relationships and their significance to the growth of family members. 1 unit. Prerequisite: Home Economics 210. MOWRER, SPORAKOWSKI.

418. Seminar in Child Development. Advanced problems in child development. 1 unit. Prerequisite: Home Economics 301. VAN DEN DAELE.

419. Seminar in Family Relationships. Critical evaluation of research literature in the field of marriage and family relationships. 1 unit. Prerequisite: Home Economics 410. MOWRER, SPORAKOWSKI.

422. Seminar in Nutrition. A study of recent literature in nutrition. ½ or 1 unit. Prerequisite: Undergraduate degree in home economics, with emphasis on foods and nutrition, or comparable background in biochemistry, microbiology, physiology, or other biological science.

423. Problems in Human Nutrition. Methods of assessing nutritional status of humans. Offered in 1970-1971 and in alternate years. ½ or 1 unit. Prerequisite: Home Economics 324 or equivalent.

430. Carbohydrates in Foods. Same as Food Science 430. A study of the physical and chemical properties of carbohydrates used in food and their behavior under conditions encountered in food processing and storage. ¾ unit. Prerequisite: Biochemistry 354 or 350 and 355, or consent of instructor.

432. Seminar in Foods. Review of current literature in foods research. ½ or 1 unit. Prerequisite: Undergraduate major in foods and nutrition, chemistry, microbiology, or physiology; consent of instructor. VAN DUYNE.

470. Seminar in Family and Consumption Economics. Same as Agricultural Economics 470. Discussion of current topics and review of the literature in family and consumption economics. ½ or 1 unit. Prerequisite: Economics 102 or 108 and a course in applied statistics; Home Economics 313, 370, or consent of instructor. DUNSING.

480. Seminar in Textiles. Current literature related to development in the production, use, and care of textile fabrics. ½ or 1 unit. Prerequisite: Home Economics 380 or equivalent; consent of instructor. GALBRAITH.

487. Seminar in Clothing. Study and discussion of research in clothing from the aspects of psychological and sociological factors contributing to the effect of clothing on the development of individuals and on family and community group reactions. ½ or 1 unit. Prerequisite: Undergraduate curriculum with majors in textiles and clothing, home economics education, home economics extension, or general home economics. ANSPACH.

493. Advanced Studies in Home Economics. Library or experimental research on specific problems of limited scope. Work may be taken in the following subjects: (a) child and family, (b) family and consumption economics, (c) family housing, (d) foods, (e) nutrition, (f) textiles and clothing. This is one of the courses which may be taken in addition to eight units required for a master's degree by students who do not write a thesis. ½ or 1 unit. STAFF.

499. Thesis Research. Work may be taken in the following subjects: (a) child and family, (b) family and consumption economics, (c) family housing, (d) foods, (e) nutrition, (f) textiles and clothing. 0 to 4 units. DUNSING, GALBRAITH, MILLS, MOWRER, J. SMITH, VAN DUYNE.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Advanced Problems in Home Guidance of Children. Emphasis is placed upon the functions and relations of routine and creative activities and the interplay of personalities in the total behavior patterns with a view to helping students understand the less obvious and more subtle aspects of child development, to differentiate between desirable and undesirable guidance procedures practiced by adult members of the family. ½ or 1 unit. Prerequisite: Home Economics 202 and 203; consent of instructor. MILLS, MOWRER.

313. Economics of Consumption. Same as Economics 313. An analysis of the macro and micro aspects of consumption. 3/4 or 1 unit. Prerequisite: Economics 102 or 108; a course in applied statistics. DUNSING.

320. Diet in Disease. 1/2 unit. Prerequisite: Home Economics 220. BROWN.

322. Physical Growth and Nutrition. Lectures, readings, and discussions. 1/2 unit. Prerequisite: Home Economics 220; consent of instructor. BROWN.

323. Recent Advances in Foods and Nutrition. New developments in foods and nutrition. Readings, lectures, and discussions. S; 1/2 unit. Prerequisite: Chemistry 102; Physiology 103; Home Economics 220 and 231.

324. Problems in Nutrition. Same as Food Science 324. Discussions and investigations. 1/2 or 1 unit. Prerequisite: Home Economics 220; Biochemistry 354 or 350 and 355; senior standing. HASKELL.

326. Presentations: Principles and Techniques. Selection of problems and organization of materials for demonstrations and other presentations in home economics subject matter areas. Field trip; estimated cost, $15.00. 1/2 unit. Prerequisite: Senior standing; consent of instructor.

330. Experimental Foods. A consideration of the manner in which such variables as ingredients, proportions, and techniques in food preparation affect the quality of the product. 3/4 or 1 unit. Prerequisite: Home Economics 231; Microbiology 100 and 101.

331. Problems in Foods. Individual problems in food preparation and preservation. 3/4 unit. Prerequisite: Home Economics 330. VAN DUYNE.

345. Institution and Restaurant Management: Food Purchasing and Equipment Selection. Purchasing food and selecting equipment for quantity food service; factors affecting the purchase of food; relationship of floor plans and equipment to service. 1/2 unit. Prerequisite: Credit or registration in Home Economics 240; Economics 108. HUNZICKER.

349. Music in Early Childhood. Same as Music 349. A detailed consideration of the music program in nursery schools, kindergarten, and the primary grades. Topics covered include the nature of early musical responses, objectives, and experience levels of the program, methods of teaching, and materials. Observation of music teaching in the Child Development Laboratory is included in the course work. 1/2 unit. Prerequisite: Senior or graduate standing in music education or child development. R. SMITH.

350. Institution and Restaurant Management: Organization and Administration. The organization and administration of food service operations; management problems in various types of food service, personnel, costs, sanitary control. Field trips; estimated cost, $20.00 to $25.00. Credit is not given for both Home Economics 350 and 351. 3/4 or 1 unit. Prerequisite: Home Economics 220 and 240. HUNZICKER.

351. Special Problems in Group Feeding. For individuals interested in refreshing and strengthening knowledge in group feeding. Lectures, discussions, laboratory practice in quantity food management. Food handler's certificate required. No credit for students who have completed Home Economics 240, 345, or 350. S; 1/2 unit. Prerequisite: Home Economics 220 and 231, or equivalent; consent of instructor.

355. Specialized Quantity Food Production and Management. Advanced application of food production and management principles to special food service demands. Emphasis on artistry in preparation, serving, and merchandising high quality food in quantity. 3/4 unit. Prerequisite: Home Economics 240, credit or registration in Home Economics 350, or consent of instructor. HUNZICKER.

361. Development and Function of Family Housing. Same as Agricultural Mechanization 361. Study of principles and problem solutions in family housing; basic functions, plan patterns, types, materials, and structure; economic influences, costs, and adaptations; personal and public interests. 3/4 unit. Prerequisite: Home Economics 160 and 171, or consent of department. HANSEN.

370. Family Economics. Same as Agricultural Economics 370. Economic welfare of American families in terms of cost of living, standard of living, income, and net worth. ¾ or 1 unit. Prerequisite: Economics 102 or 108; a course in applied statistics. DUNSING.

375. Home Equipment. A survey course in which the basic principles related to the selection, use, and care of household equipment are considered. Individual problems include an evaluation of sources of information on equipment and equipment performance tests. ½ unit. Prerequisite: Home Economics 171; six advanced hours in home economics, including one of the following: Home Economics 231, 273, 380; consent of instructor.

377. Cooperative Extension: Home Economics. The philosophy, history, and organization of the cooperative extension service. Consideration of program development, methods of presentation, and evaluation with emphasis on socio-economic characteristics of state and county. ½ to 1 unit. Prerequisite: Economics 108; Psychology 100 and Sociology 100, or Educational Psychology 211, or Agriculture 206; consent of instructor. DUNLAP.

378. Problems in Home Management. Individual investigation and reports of specific problems in the fields of family housing, home furnishings, and home management. ½ to 1 unit. Prerequisite: Home Economics 262 or 270; consent of instructor. ALEXANDER, GOODYEAR.

379. Problems in Family and Consumption Economics. Individual investigation of specific problems in the field of family and consumption economics. ½ or 1 unit. Prerequisite: Economics 102 or 108; a course in applied statistics; Home Economics 313, 370, or consent of instructor. DUNSING.

380. Advanced Textiles. The effect of the physical and chemical structures of textile fibers on their properties, manufacturing processes, use, and care. 1 unit. Prerequisite: Home Economics 183; Chemistry 102. GALBRAITH.

386. Clothing Design: Draping. Designing by draping, inspired by appropriate design sources; understanding of fitting principles through fabric manipulations; design effects maintained in garment construction. 1 unit. Prerequisite: Home Economics 285 or consent of instructor; Home Economics 286. ANSPACH.

388. Problems in Textiles and Clothing. Investigation and report of individual problems in the field of textiles and clothing. ½ or 1 unit. Prerequisite: Home Economics 286 or 380 or Business Administration 212; consent of instructor. ANSPACH, GALBRAITH, TREBILCOCK.

395. Fashion Analysis. A study of fashion terminology, selected designers, garment manufacturing techniques, and methods of fashion promotion used in retail outlets. Field trip; estimated cost, $10.00. ½ unit. Prerequisite: Advertising 281; consent of instructor. TREBILCOCK.

HORTICULTURE

Graduate work is offered in the Department of Horticulture leading to the Master of Science and Doctor of Philosophy degrees. Students may specialize in any phase of horticulture including genetics, physiology, ecology, developmental anatomy, or marketing. Apiculture is offered jointly with the Department of Entomology. Well-equipped laboratories and extensive experimental farms are available for each area of specialization within the department. Special facilities available on campus include the computer laboratory, electron microscope laboratory, and radioisotope laboratory. A well-balanced program may be achieved by taking courses in agronomy (crops or soils), botany, food science, genetics, statistics, plant pathology, chemistry, biochemistry, entomology, or agricultural economics. Students may minor in any of these fields.

Applicants with a grade-point average of 4.0 or above for the last sixty semester credit hours of course work for the bachelor's degree are admitted for graduate study in horticulture.

Applicants with an average below 4.0 but above 3.75 are considered on an individual basis. Applicants should have adequate preparation in the fundamental sciences.

A minimum of eight units must be completed for the master's degree. A candidate for the degree of Doctor of Philosophy must complete eight units of courses beyond the master's degree and pass an oral preliminary examination. The candidate must also complete eight units of thesis research and submit an acceptable thesis.

Additional information concerning specific requirements and opportunities in graduate research is available from the Head of the Department of Horticulture, 125 Mumford Hall.

FACULTY

Professors: C. J. Birkeland (Head of Department), C. Y. Arnold, J. R. Culbert, D. F. Dayton, J. B. Gartner, E. R. Jaycox, M. B. Linn, J. P. McCollum, D. Powell, R. K. Simons, A. E. Thompson, J. S. Titus, J. S. Vandemark.

Associate Professors: L. Beevers, D. B. Dickinson, T. K. Hodges, A. M. Rhodes, C. C. Zych.

Assistant Professors: J. D. Butler, H. J. Hopen, M. M. Meyer, W. E. Splittstoesser.

COURSES FOR GRADUATES

424. Mineral Nutrition of Plants. Same as Agronomy and Botany 424. A study of the uptake, transport, and metabolic utilization of mineral nutrients by plants. The scope of the course is to present the essentiality of various anions and cations in the light of metabolic activity and constituency in functional plant compounds. Major emphasis is placed on metabolic activity and function of the elements. 1 unit. Prerequisite: Botany 330 or consent of instructor. Hageman.

440. Design and Analysis of Biological Experiments. Same as Agricultural Engineering, Agronomy, Animal Science, Dairy Science, Food Science, Forestry, and Veterinary Medical Science 440. Statistical methods as tools for research. Principles of designing experiments and methods of analysis for various kinds of designs, including factorial experiments, are considered from the viewpoint of when and how to use them. $^3/_4$ unit. Prerequisite: Horticulture 340 or equivalent.

447. Horticulture Seminar. Discussion of current research and literature pertaining to problems of horticulture and related fields. $^1/_4$ unit. Staff.

490. Research Methods in Horticulture. Lectures, discussions, demonstrations, and laboratory exercises dealing with methods and apparatus used in horticultural research. 1 unit. Prerequisite: Chemistry 133 or equivalent; Chemistry 122 or equivalent; Botany 330; five hours of physics. McCollum, Splittstoesser.

492. Special Topics in Horticulture. Readings and discussions in selected phases of horticulture including such topics as genetics, physiology, anatomy, morphology, and ecology of horticultural crops. $^1/_2$ to 2 units. Prerequisite: Twenty hours of undergraduate work in horticulture and allied subjects for a major and twelve hours for a minor. Staff.

499. Thesis Research. Research on the thesis problem in floriculture, fruit breeding, pomology, and vegetable crops. Required in horticulture major. 0 to 4 units. Prerequisite: Twenty hours of undergraduate work in horticulture and allied subjects for a major and twelve hours for a minor. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

321. Floricultural Physiology. A study of the physiology and metabolism of floricultural crops during their development from seeds through flowering. Lectures and discussion. 1 unit. Prerequisite: One semester of organic chemistry and introductory plant physiology, or equivalent. Beevers.

322. Plant Nutrition. A study of the mechanisms of and factors affecting the absorption,

transport, and functions of the essential elements required by higher plants. Lectures, discussions, and laboratory. 1 unit. Prerequisite: One semester of organic chemistry and introductory plant physiology, or equivalent. HODGES.

323. Principles of Plant Breeding. Same as Agronomy 323. Genetic and cytological variation in crop plants, the production and control of such variation in developing varieties and hybrids, the maintenance of high quality seed stocks. Field trips; estimated cost, $5.00. 1 unit. Prerequisite: Agronomy 110 or equivalent; Botany 100. HADLEY, HITTLE, THOMPSON.

335. Economics of Food Distribution. Same as Agricultural Economics 335. Analysis of (1) marketing structures and operations in the manufacture and wholesale and retail distribution of food; (2) effects of industry organization and governmental regulations on marketing functions and efficiency; (3) consumer demand for food. ¾ or 1 unit. Prerequisite: Economics 108; Agricultural Economics 230 or an elementary marketing course. KELLY.

340. Introduction to Applied Statistics. Same as Agricultural Engineering, Agronomy, Animal Science, Dairy Science, Food Science, Forestry, and Veterinary Medical Science 340. Statistical methods involving relationships between populations and samples; collection, organization, and analysis of data; techniques in testing hypotheses with an introduction to regression, correlation, and analyses of variance limited to the completely randomized design and the randomized complete-block design. ¾ unit. Prerequisite: Mathematics 111 or 112 or 104, or equivalent.

345. Growth and Development of Horticultural Crops. Factors affecting growth, development, and quality of vegetable crops. Lecture and discussion. Offered in 1971-1972 and in alternate years. 1 unit. Prerequisite: Botany 330 or equivalent, or consent of instructor. MCCOLLUM.

361. Individual and Group Behavior of Honey Bees. Same as Entomology and Zoology 361. Study of individual and group behavior of honey bees, their biological value, physical basis, and evolution. Lectures and discussions, one or more local field trips, term paper, and assigned reading. ½ unit. Prerequisite: One semester of entomology or zoology. JAYCOX.

HUMANITIES

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

363. Introduction to Comparative Literature, I. Same as Comparative Literature 363. A one-year course in two parts, offering a survey of methods and goals of comparative literature, illustrated by representative examples taken from several literatures and studies of modern criticism. ¾ unit.

364. Introduction to Comparative Literature, II. Same as Comparative Literature 364. Continuation of Humanities and Comparative Literature 363. ¾ unit.

INDUSTRIAL ADMINISTRATION

See descriptions and course listings under Business Administration, page 101.

ITALIAN

See descriptions and course listings under Spanish, Italian, and Portuguese, page 376.

JOURNALISM

The Department of Journalism offers graduate work leading to the Master of Science in Journalism. For the program leading to the Doctor of Philosophy in Communications, see page 138.

Admission to graduate work in journalism requires (1) completion of the requirements for a bachelor's degree in an institution of recognized standing, preferably with a major (normally twenty semester credit hours) in journalism or a related field such as English or the social sciences; and (2) a grade-point average of at least 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

Requirements for the master's degree include:

(1) A major of four units, or three units and one additional unit approved by the department. Candidates without acceptable undergraduate majors may be required to complete (a) one unit of Journalism 321, (b) one unit of advanced undergraduate courses in writing or editing, and (c) in individual cases, some combination of Journalism 204, 211, 223, and 291, without graduate credit.

(2) A minor of at least two units, normally in an area outside the College of Communications.

(3) A thesis of one unit (Journalism 499) or the preparation of a topic of general public interest for publication or broadcast (Journalism 490).

(4) A minimum of three units in courses at the 400 level, at least two of which must be in the major field.

(5) A comprehensive written examination in the student's major and minor fields and on the current master's reading list.

(6) A minimum total of eight units.

FACULTY

Professors: J. W. Jensen (Head of Department), T. Peterson, H. I. Schiller.

Associate Professors: J. W. Carey, G. Graham, H. S. Maclay, J. H. Schacht, Nancy Wiggins.

Assistant Professors: G. Gilmore, T. H. Guback, P. Knights, H. Ziff.

COURSES FOR GRADUATES

468. The Political Economy of Communications. Same as Communications 468. Analysis of the structure, policy, and behavior of such media of communication as newspapers, magazines, books, postal service, telegraph, telephone, broadcasting, and film, with special emphasis on their relationships to political order and the economy. 1 unit. Prerequisite: Consent of College of Communications. Guback, Schiller.

470. Communications and Popular Culture. Same as Communications 470. Problems of cultural analysis related to the media of communications; social implications of communications research. 1 unit. Prerequisite: Consent of College of Communications. Carey, Guback, Schacht.

471. Proseminar in Communications, I. Same as Communications 471. A general discussion of the mass media of communications, their role as social institutions, their control, and support; content, audience, and effect of the mass media. 1 unit. Prerequisite: Consent of College of Communications. Carey, Maclay, Staff.

472. Proseminar in Communications, II. Same as Communications 472. A general discussion of the problem of communications, including the individual as a communicating system, symbolic processes, analysis of messages, psycholinguistics, and language as social behavior. 1 unit. Prerequisite: Consent of College of Communications.

473. History and Theory of Freedom of the Press. Same as Communications 473. Development of the Anglo-American press system and the idea of freedom of the press; contemporary mass media and their implications for freedom and democracy. 1 unit. Prerequisite: Consent of College of Communications. Jensen, Peterson.

474. Communications Systems. Same as Communications 474. Analysis of the structure and development of communications systems; examination of the role of communication in social change, political movements, and formal organizations. 1 unit. Prerequisite: Consent of College of Communications. CAREY, SCHILLER.

490. Special Topics in Journalism. ½ or 1 unit. Prerequisite: Consent of head of department. STAFF.

492. Research Methods in Communications. Same as Communications 492. An introduction to the methods of empirical research in the behavioral sciences applicable to research problems in human communication, with emphasis on studies of mass communication. Lectures, readings, and laboratory practice. 1 unit. Prerequisite: Consent of College of Communications. WIGGINS.

499. Thesis Research. 1 to 2 units. Prerequiste: Graduate standing in journalism. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

308. High School Journalism. Journalistic writing in the high school; newspaper study and training of newspaper readers; supervision of school publications and publicity; junior college courses in journalism. ½ unit. Prerequisite: Consent of instructor. GILMORE.

310. Typographic Disciplines of the Book. Same as Library Science 310 and English 392. The study of the book as a manufactured object, with emphasis upon practices and methods in continuous use from the Renaissance to the present, including type faces, paper, binding, and illustration. Extensive practicum in the typographic laboratory. ½ unit. Prerequisite: Consent of instructor.

321. News Editing. Newspaper desk work; editing the news; correction of faulty news stories; handling wire copy. Attention to headwriting, news pictures, and make-up and design of newspaper pages. 1 unit. Prerequisite: Credit or registration in Journalism 204 and 212; registration in College of Communications; or consent of College. GILMORE, GRAHAM, SCHACHT.

323. Advanced Reporting. Advanced types of news investigation and treatment. ½ unit. Prerequisite: Journalism 211 and 212; registration in College of Communications; or consent of College. GRAHAM, ZIFF.

326. Magazine Article Writing. Preparation of feature stories and articles; techniques of marketing, market analysis, and publishing articles written in the course. ½ unit. Prerequisite: Journalism 211; registration in College of Communications; or consent of College. GRAHAM, SCHACHT.

327. Special Topics in Twentieth-Century Journalism. Special topics, particularly on recent developments in such areas as radio, advertising, television, and modern magazines. ½ unit. Prerequisite: Journalism 211; registration in College of Communications; or consent of College. KNIGHTS, ZIFF.

329. The Rhetoric of Journalism. Studies in journalistic method, involving principally the analysis of structure and writing style as related to purpose. Materials are drawn from English and American journalism from the seventeenth century to the present, but emphasis is on work published in twentieth-century American newspapers and periodicals. ½ unit. Prerequisite: Journalism 211 or consent of instructor. SCHACHT.

330. Magazine Editing. Basic principles of editing for consumer, business, trade, and company magazines; communications theory, market analysis, editorial process, design process, production process, and distribution process as they relate to magazine publishing. ½ unit. Prerequisite: Credit or registration in Journalism 326. SCHACHT.

341. Newspaper Management. Principles and methods in the operation of daily and weekly newspapers; managerial problems of the editorial, advertising, circulation, and commercial printing departments; plant operation. ½ unit. Prerequisite: Credit or registration in Journalism 204.

344. Community Newspaper Publication. Study of weekly and small- and medium-sized daily newspapers in handling news, editorials, features, pictures, and correspondence; and in meeting business, circulation, and advertising problems. Includes one or more field trips for each student, with actual work on a small newspaper. ½ unit. Prerequisite: Journalism 212 or consent of instructor. GILMORE.

LABOR AND INDUSTRIAL RELATIONS

The Institute of Labor and Industrial Relations offers a Master of Arts and a Doctor of Philosophy in Labor and Industrial Relations. Graduate instruction is offered in trade union and management organization, in the accommodation of these organizations through the process and structure of collective bargaining, in personnel administration and employee relations, in manpower programs and policy, in the role of the government in legislating labor standards and labor relations, and in the formulation of public policy. These matters are studied in the context of social, economic, and political change and are analyzed with the help of theoretical and empirical formulations of economics, history, law, political science, psychology, and sociology.

Master of Arts. A student seeking admission to the master's program in the Institute must meet the general entrance requirements of the Graduate College. In addition, a faculty committee reviews the undergraduate record of every candidate and may refuse admission to a student whose record indicates inadequate preparation. A course in statistics is the only prerequisite for admission, although course work in the various social sciences is desirable preparation for the Institute program.

Candidates for the master's degree have a choice of study programs. Program A requires eight units of graduate credit, two of which are granted for successful completion of a thesis. Program B requires ten units of course work. Common requirements in both programs include one unit of credit in research methods, one unit of credit in quantitative analysis, responsibility for a list of required readings, and a comprehensive oral examination.

Doctor of Philosophy. Admission to the doctoral program is granted only to those students whose undergraduate and graduate records indicate that they are likely to complete successfully the requirements for the Ph.D. Admission requirements are a master's degree or equivalent in labor and industrial relations or an allied field, a master's thesis or similar evidence of research competence, and three letters of recommendation. Prerequisites are courses in labor problems, statistics, and college algebra; first-year calculus is recommended. Minimum preparation in the social sciences is an undergraduate major in economics, history, political science, psychology, or sociology, or at least nine hours in each of two social sciences.

The candidate's course work is concentrated in two or more social science disciplines related to a selected area of specialization; in addition, five units of course work in industrial relations theory and methodology are required. The candidate may select one of the following four areas for specialization: (1) industrial relations systems and public policy; (2) wages, labor market behavior, income security, and manpower analysis; (3) labor and management organizations and labor-management relations; (4) interpersonal and intergroup behavior.

Students taking master's or doctoral degrees in other departments—economics, business administration, communications, history, political science, psychology, sociology, and others—may arrange a minor in labor and industrial relations.

Full details of the Institute program and requirements are given in the publication, *Graduate Study at the Institute of Labor and Industrial Relations*, which may be obtained by writing to the Institute of Labor and Industrial Relations.

FACULTY

Professors: M. ROTHBAUM (Director of the Institute of Labor and Industrial Relations), M. DERBER, H. FOLK, W. H. FRANKE, P. L. GARMAN, B. KARSH, W. MCPHERSON, A. F. STURMTHAL, K. TAIRA, H. C. TRIANDIS, M. WAGNER.

Associate Professors: A. Green, P. T. Hartman, C. L. Hulin, J. Scoville.
Assistant Professors: P. Gerhart, G. B. Graen, J. Kimberly.

COURSES FOR GRADUATES

418. Seminar in Industrial and Economic Sociology. Same as Sociology 418. Discussion and individual research on such topics as industrialization, labor-management relations as group relations, the interrelations of industry and community, technology and the structure of controls in industry, and the problem of a social economics. 1 unit. Prerequisite: Labor and Industrial Relations 318 or consent of instructor.

420. Formation of Public Policy. Same as Political Science 420. An examination of the institutional and dynamic forces that shape the making of policy and its administration in the United States; separation of powers, pressure groups, administrative and legislative procedures, and judicial activity. 1 unit.

435. Motivation and Morale in Industry. Same as Psychology 435. Concepts and methods in the study of motivation of employees; determinants of employee attitudes and job satisfaction; modification of attitudes and morale. 1 unit. Prerequisite: Four units of graduate credit in psychology or consent of instructor.

440. Labor Economics. Same as Economics 440. A survey of recent trends in the labor force, or real and money earnings, and of the distribution of national income. This review of recent trends in these areas is used as the basis for a critical economic analysis of contemporary English and American wage theory. 1 unit. Prerequisite: Economics 300 and 301.

441. Labor Economics. Same as Economics 441. The economic issues and implications involved in hours of work, employment and unemployment, and trade union institutionalism (the impact of the trade union upon the basic institution of a free enterprise economy). Emphasis in all cases is upon the development of appropriate public policy. 1 unit. Prerequisite: Economics 300 and 301.

442. Collective Bargaining. Same as Economics 442. The development of a theory of the continuing interactions between union and management which define and modify the role of each and the terms of employment. Appropriate social science concepts are used. Emphasis is on the negotiating process, the structure of bargaining, and such issues as wages, worker security, and management authority as well as on the interactions between the parties and the governmental process. 1 unit. Prerequisite: Consent of instructor.

443. Problems and Practices of Labor Dispute Settlement. Same as Economics 443. Seminar in the policies and practices of labor contract administration; comparative study of the fundamentals of grievance handling; analysis of mediation and fact-finding techniques; and special emphasis on the use of arbitration as a means of reducing industrial conflict. 1 unit. Prerequisite: Consent of instructor.

444. Economics of Manpower Resources. Same as Economics 444. Emergence of the manpower resource issue; population as a resource base; the labor force; measurement and characteristics, behavior under changing income, employment, technology; women as the dynamic factor in labor force growth; problems of utilization of labor force components; intellectual resources, older workers, manual, white collar, Negro, marginal forces; issues of national manpower policy. 1 unit. Graduate credit is not given for both Labor and Industrial Relations or Economics 345 and Labor and Industrial Relations or Economics 444. Prerequisite: Consent of instructor.

445. Investment in Human Resources. Same as Vocational and Technical Education 445. Activities which influence future monetary and psychic income by improving the resources in people. The investments covered include schooling, on-the-job training, medical care, migration, and the search for information on prices and incomes, with main emphasis on education. A last section covers educational planning. 1 unit. Prerequisite: An introductory course in economics and in quantitative methods.

446. Foreign and International Labor Movements. History and organization, economic and political policies of the major labor movements in the world; their international organizations; comparative analysis of particular problems confronting these movements; labor movements in underdeveloped areas; labor and economic development; labor under totalitarian regimes. 1 unit. Prerequisite: Consent of instructor.

447. Labor Union Organization and Administration. Same as Economics 447. Analysis of the structure, functions, and government of the modern American trade union movement. Provides a survey of the environmental factors, objectives, and action programs with considerable emphasis on economic as well as internal institutional factors, including the roles of leaders, policy determination and execution, jurisdictional disputes, and governmental regulations. 1 unit. Prerequisite: Major in social science or consent of instructor.

448. Problems of Personnel Management. Same as Business Administration 448. An examination of the organization and administration of the personnel function in management. The course deals with the relations of personnel administration to operating departments, and the scope of business and industrial personnel services. Analytical appraisal of policies and practices in selected areas of personnel administration, such as selection and training, is carried out through case studies and direct industrial contacts. Specific consideration is given to problems up to and including placing the person on a job. 1 unit. Prerequisite: Business Administration 248 or equivalent; consent of instructor.

449. Problems of Personnel Management. Same as Business Administration 449. A seminar and laboratory course dealing with the problems and practices encountered by personnel managers subsequent to the employment process. Students do field work in businesses and industries in the area on such topics as incentives, rating, employee services, and community relations. 1 unit. Prerequisite: Business Administration 248, 448, or equivalent.

450. Management and Industrial Relations. An analysis of the industrial relations function in management. Using case problems, research reports, and theoretical analyses, an examination is made of the development of the industrial relations function, alternate organizational approaches in dealing with employees and unions, the formation of labor relations policies, and management responsibilities in industrial relations. 1 unit. Prerequisite: Consent of instructor.

490. Individual Topics. A student in labor and industrial relations may register for this unit with the consent of his curriculum adviser and the adviser under whom he will perform the individual study or research. Such individual work may include special study in a subject matter for which no course is available or an individual research project, including on-the-job research in industry, which is not being undertaken for a thesis. 0 to 2 units. Staff.

492. Research Seminar in Labor and Industrial Relations. Systematic analysis of theories and procedures of the various social and physical sciences bearing on research in labor and industrial relations. Primary emphasis is on the process of integrating the approaches and techniques of the various social sciences with respect to the study of problems in labor and industrial relations as met in practice in management, the union, and government service, as well as in teaching and research in the field. 1 unit. Prerequisite: Major in social sciences or consent of instructor.

493. Quantitative Methods in Labor and Industrial Relations. An introduction to statistical concepts and methods in the social sciences and their application to industrial relations problems. The course familiarizes the student with modern methods of probability sampling, statistical inference, and multivariate analysis, and their application to current research problems in labor and industrial relations. 1 unit. Prerequisite: Any elementary statistics course, such as Economics 170.

494. The Major Theorists of Industrial Relations. An integrated analysis of the principles of labor relations through the study of the works of the major theorists and their critics. 1 unit. Prerequisite: Consent of instructor.

495. Application of Theory to Contemporary Problems in Labor and Industrial Relations. A seminar for advanced graduate students in the application of social science and industrial relations theory and research methodology to selected contemporary problems. Seminar discussions focus on work developed by the seminar members. 1 unit. Prerequisite: Labor and Industrial Relations 493 and 494, or consent of instructor.

496. The Evolution of Labor-Management Relations in America. Analysis and interpretation of the development of labor-management relations at the plant and industry levels from the stages of master and servant and master and journeyman in colonial times to the stage of constitutional government and industrial democracy in the present day. 1 unit. Prerequisite: Graduate standing in labor and industrial relations or consent of instructor.

498. Analysis of Organizations in Industrial Relations. An intensive analysis of organizational behavior, with the main focus upon the theory of organizations as social institutions. Concepts are drawn from the various social sciences and applied to the principal organizations concerned with industrial relations. The internal dynamics of unions, managements, and government agencies are examined, with special reference to decision-making processes, and are related to the interactions among them. 1 unit. Prerequisite: Consent of instructor.

499. Thesis Research. For all students writing theses in labor and industrial relations. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

315. The Economics of Poverty and Income Maintenance. Same as Economics 315. An economic analysis of the nature and causes of poverty with special emphasis on critical evaluation of programs to combat poverty in the United States. ½ or 1 unit. Prerequisite: Economics 103 or 108.

318. Industry and Society. Same as Sociology 318. Introduction to the sociology of economic institutions; selected problems of technological change and industrialization; corporate organization and trade union structure; human relations in industry and the changing bases of managerial authority; changing consumption patterns and the redefinition of work and leisure. ½ or 1 unit. Prerequisite: Six hours of sociology including one of the following: Sociology 218, 223, 300, 322, 326, or consent of instructor.

321. Industrial Social Systems, I. Same as Business Administration 321. Particular forms of individual and group behavior in organizations within the constraints of the economic, social, technological, and physical environment; the relations between union and management; the interdependency of these factors with the decisions managers make. ½ to 1 unit. Prerequisite: Business Administration 210; Psychology 100; Psychology 201 or consent of instructor.

341. The Economics of Labor Markets. Same as Economics 341. A study of the theory and empirical research in wage determination, wage structure, economic effects of unions and macroeconomic labor market problems. Topics include: determinants of interindustry and occupational wage differentials; aggregate labor supply functions; effects of unions on relative wages; cost-push inflation; wage-price-unemployment dilemma models; disguised and structural unemployment; employment and income policies. ½ or 1 unit. Prerequisite: Economics 103 or 108.

343. Unions, Bargaining, and Public Policy. Same as Economics 343. Analysis of the legal background and economic issues associated with unions and collective bargaining in the United States. Includes theory of the labor movement; processes of union wage determination; analysis of strikes; background, strategies, and principal issues in collective bargaining; problems and policies of government intervention. ½ or 1 unit. Prerequisite: Economics 103 or 108.

345. Economics of Manpower. Same as Economics 345. Manpower training in economic growth, labor force characteristics, occupational structure and future manpower re-

quirements, job information networks, economics of discrimination and underutilization, national manpower policies and programs, private industry and union manpower planning. ½ or 1 unit. Graduate credit is not given for both Labor and Industrial Relations or Economics 345 and Labor and Industrial Relations or Economics 444. Prerequisite: Economics 103 or 108.

347. Labor Law, I. Same as Law 347. The law of industrial relations with special emphasis on recent cases and legislation; the establishment of the collective bargaining relationships; strikes, boycotts, and picketing; Federalism and labor relations. 1 unit.

355. Industrial Social Psychology. Same as Psychology 355. Social psychological research and theory applied to industrial problems. Emphasis upon interaction and communication theory, role theory, leadership theory, motivational and perceptual theory, and group structure theory as an aid to understanding and analyzing industrial problems. ½ or 1 unit. Prerequisite: Psychology 255 or Labor and Industrial Relations 357.

357. Psychology of Industrial Conflict. Same as Psychology 357. An analysis, in terms of the behavior of individuals, of the causes and possible solutions of industrial conflict. ½ or 1 unit. Prerequisite: Psychology 100 or equivalent. Offered in special interest of industrial relations, commerce, and engineering students.

360. Employee Benefit Plans. Same as Finance 360. An analysis of the economic and financial issues involved in designing and administering employee benefit plans; major emphasis is given to group life, disability income, and medical care plans, and to "qualified" pensions, and profit-sharing plans for regular employees; some attention is given to special, supplementary plans for the executive employees. ½ to 1 unit. Prerequisite: Finance 260, Economics 240, or Business Administration 351; or consent of instructor.

365. Government and Labor. Same as Political Science 365. Critical analysis of the relationship between group pressures on government and public policy affecting labor; role of administration in formation of policy; problems and experience of federal agencies operating in the labor fields. ½ or 1 unit. Prerequisite: Political Science 150 or 191.

LANDSCAPE ARCHITECTURE

The Department of Landscape Architecture offers work leading to the Master of Landscape Architecture degree. Areas of study interest are urban design, landscape resources, and professional education. A pamphlet giving detailed information on the program is available upon request.

Candidates for admission must possess a bachelor's degree in landscape architecture or related fields. Those whose undergraduate work is not substantially equivalent in scope and standards to that of the Department of Landscape Architecture at the University of Illinois must expect to complete prerequisite courses before pursuing advanced study in the graduate program.

Minimum grade-point average for admission is 3.75 for the last sixty hours of undergraduate study. Candidates with lower averages are considered on an individual basis if they possess significant experience in professional landscape architectural work before applying. Candidates from undergraduate design programs must accompany applications with samples of their design work.

To qualify for this degree, a student must complete a minimum of eight units distributed as follows: (1) three and one-half units totaled from Landscape Architecture 437, 477, 487, and 499; (2) two units selected from Landscape Architecture 435, 436, 457, and 467, according to the chosen interest area; (3) two and one-half units of electives chosen from 300- or 400-level courses offered outside the department. Students are expected to follow one of the recommended interest area programs although approval may be obtained from the department chairman for a special program. Elective possibilities are extensive and many course and research projects are selected by the student. Accordingly, there is ample opportunity to tailor a program to meet individual needs.

To encourage scholarly interaction, students from other disciplines are encouraged to consider landscape architecture courses where consent of instructor is stated as a prerequisite.

FACULTY

Professors: W. G. Carnes (Chairman of Department), T. C. Hazlett, W. M. Keith.
Associate Professors: A. J. Rutledge, D. L. Walker, Jr.

COURSES FOR GRADUATES

435. Urban Design. Design development of new or renewed urban areas and systems in collaboration with architecture and urban planning students. 2 units. Prerequisite: Passage of special design examination; credit or registration in Urban Planning 384.

436. Advanced Landscape Design. Comprehensive master planning and site design for large public, semipublic, and private properties. Special problems in collaboration with students from other disciplines are encouraged. 1 unit. Prerequisite: Passage of special design examination or consent of instructor.

437. Regional Landscape Design. Detailed investigation of landscape resources and characteristics of large geographical areas; determination of land use design proposals. 1 unit.

457. Landscape Management. Investigation of management theories, policies, and practices which influence landscape preservation and development, with emphasis on their cumulative effects upon natural processes and aesthetic qualities. 1 unit. Prerequisite: Consent of instructor.

467. Landscape Architecture Professional Education. Investigation and analysis of philosophies, concepts, structures, and techniques of professional landscape architecture educational programs. 1 unit.

477. Development of Landscape Architectural Thought. Exploratory study of times, traditions, and philosophies which have shaped past and present attitudes toward landscape development; application to contemporary issues. $\frac{1}{2}$ unit. Prerequisite: Consent of instructor.

487. Seminar. Preparation, presentation, and discussion of research papers on current and future areas of landscape architectural application. $\frac{1}{2}$ unit. Prerequisite: Consent of instructor.

490. Special Problems. For students from disciplines other than landscape architecture. Individual projects and research in collaboration with landscape architecture students. Opportunity for interaction among those whose disciplines are concerned with the development, use, and effects of the physical environment. Nature and scope of problems determined in consultation between student and faculty adviser. $\frac{1}{2}$ to 1 unit. Prerequisite: Consent of instructor.

499. Thesis Research. 0 to $1\frac{1}{2}$ units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

337. Advanced Landscape Design, I. Advanced problems of landscape design for urban and institutional situations. 1 to $1\frac{1}{2}$ units. Prerequisite: Landscape Architecture 236.

338. Advanced Landscape Design, II. Terminal project; comprehensive landscape architectural development. 1 to 2 units. Prerequisite: Landscape Architecture 337.

LATIN-AMERICAN STUDIES

Graduate minors in Latin-American studies are administered by the Director of the Center for Latin-American Studies.

Candidates for the master's degree who elect a minor in Latin-American studies must complete two units from the courses prescribed by the Center for Latin-American Studies.

Doctoral candidates who elect a minor in this area must complete four units for a sole minor, or two units for a split minor. Courses must be taken in at least two departments; lists of courses fulfilling the minor are available from the Center.

Students in technical and professional colleges and schools of the University who seek knowledge of Latin-American affairs, culture, and languages are invited to consult with the Director of the Center for Latin-American Studies, 1208 West California Avenue, Urbana, or with their advisers, in order to develop programs suited to their individual needs. Such a program may often be adopted as a special minor under existing regulations if the student so desires. These courses are of particular value to students who intend to carry on technical or professional work in the Latin-American area for the government, private business, publications, or religious organizations.

FACULTY

Professors: J. Allen, J. Augelli (Director of Center for Latin-American Studies), J. Casagrande, F. Dovring, M. Forster, D. Lathrap, L. Leal, O. Lewis, E. Rae, R. Scott, J. Thompson.
Associate Professors: J. Love, S. Schmidt, R. Zuidema.
Assistant Professors: G. Behague, R. Byars, M. Solaún, R. Vandendries.

LAW

The College of Law offers a program of graduate work leading to the Master of Laws (LL.M.), Master of Comparative Law (M.C.L.), and Doctor of the Science of Law (J.S.D.).

A student whose undergraduate study in law has been in systems based on the Anglo-American common law is eligible to apply for candidacy for the Master of Laws or Doctor of the Science of Law. A foreign lawyer whose prior law study has been in a system which is not based on the Anglo-American common law may, in exceptional cases, be admitted to candidacy for the Master of Laws or Doctor of the Science of Law, or such foreign lawyer may apply for candidacy for the Master of Comparative Law. The Master of Comparative Law program is designed to develop facility in the comparative method and to prepare a foreign lawyer to deal knowledgeably with Anglo-American problems.

For admission, an applicant must have received a first degree in law from a law school which has graduation requirements substantially the same as the University of Illinois College of Law, and must present evidence of ability to do satisfactory work at the graduate level. Normally no student is admitted as a candidate for the Master of Laws unless he has a grade-point average of 4.0 in all law work previously undertaken. A student who is a candidate for the degree of Doctor of the Science of Law is normally required to have a grade-point average of 4.0 in all law work previously undertaken, and also to present evidence that he has the ability to do independent research; the latter requirement may be met by the submission of satisfactory legal writing done while the applicant was a candidate for the Doctor of Law (or equivalent degree), or subsequent to the receipt of that degree.

One academic year in residence is required of a candidate for an advanced degree. The programs consist of course work and research which have been approved by the committee on graduate study of the College of Law, comprising at least eight units of graduate work of which at least two for the master's degree and four for the doctor's degree must be in research. In addition to the course work and research, a thesis is required. For the master's degree, the thesis may be completed during the year in residence. For the doctor's degree, the thesis must be submitted not less than one year nor more than five years after the completion of the residence requirements, and the candidate must pass an oral examination before a committee of the faculty. The candidate for the Master of Laws must secure an average of 3.5 in his graduate law courses; the candidate for the Doctor of the Science of Law, an average of 4.0.

Details of the programs may be obtained from the Dean of the College of Law, 209 Law Building.

FACULTY

Professors: J. E. Cribbet (Dean of College of Law), D. C. Baum, M. W. Benfield,

C. H. Bowman, R. G. Cohn, R. W. Findley, G. T. Frampton, S. B. Goldberg, P. H. Hay, H. D. Krause, W. R. LaFave, P. B. Maggs, P. H. Marshall, J. O'Connell, S. J. Plager, C. W. Quick, R. Reisner, H. Semmel, V. J. Stone, J. N. Young.

Associate Professors: M. P. Dooley, B. S. DuVal, Jr., J. H. McCord, L. W. Waggoner.

Assistant Professor: E. J. Kionka.

COURSES FOR GRADUATES

400. Seminar: Legal Education. Problems in legal education, curricula, teaching materials, methods of teaching, the place and function of individual courses in the law school program. ½ unit.

499. Thesis Research. ½ to 3 units.

PROFESSIONAL COURSES

301. Contracts A. Offer and acceptance, consideration, seals, Statute of Frauds. 1 unit (for recommended M.C.L. candidates only). Benfield, Hay, Maggs.

302. Contracts B. Third-party beneficiaries, assignment, conditions, impossibility, anticipatory repudiation, and discharge; contract and quasi-contract distinguished, and measure of damages for each. 1 unit (for recommended M.C.L. candidates only). Prerequisite: Law 301. Benfield, Hay, Maggs.

303. Torts A. Basic course in civil wrongs, including intentional infliction of emotional harm, right of privacy, libel and slander, and unfair commercial practices. ½ unit (for recommended M.C.L. candidates only). Krause, O'Connell, Quick.

304. Torts B. Basic course in civil wrongs, including negligence, liability without fault, tort liability of owners and occupiers of land, and the impact of insurance on tort liability. 1 unit (for recommended M.C.L. candidates only). Prerequisite: Law 303. Krause, O'Connell, Quick.

305. Judicial Remedies. Introduction to civil procedure, common-law forms of action, extraordinary legal remedies, nature of equity jurisprudence, equitable remedies, abolition of the forms of action, fusion of law and equity, statutory remedies. 1 unit (for recommended M.C.L. candidates only). Marshall, Semmel, Stone.

307. Property A. The concept of property; acquisition of private property; recognized property interest (personal, real, estates in land). 1 unit (for recommended M.C.L. candidates only). Cribbet, Findley, Plager.

308. Property B. Gratuitous transfer of property interests; commercial transfers (sale, lease); the use of property. 1 unit (for recommended M.C.L. candidates only). Prerequisite: Law 307. Cribbet, Findley, Plager.

309. Criminal Law. The sources and purposes of the criminal law; the meaning of criminal responsibility; the characteristics of particular crimes. 1 unit (for recommended M.C.L. candidates only). Bowman, LaFave.

310. Constitutional Law. The apportionment of governmental power between the United States and the states, and the limitations on power resulting from the contract, equal protection, and due process clauses. 1 unit (for recommended M.C.L. candidates only). DuVal, Goldberg, Reisner.

320. Business Associations. The fundamental legal consequences to principals, agents, and third parties of association in various types of business transactions and in various forms of business enterprise. 1 unit (for recommended M.C.L. candidates only). Baum, Frampton.

322. Commercial Law, I. A study of the major problems involved in the exchange of goods and commercial paper with special emphasis upon the history and interpretation of the Uniform Commercial Code as it affects commercial transactions. 1 unit. Benfield, Dooley.

323. Administrative Law. The functions of administrative tribunals in federal, state, and municipal government, the procedure before such administrative tribunals, and judicial relief from administrative decisions. 1 unit. COHN.

324. Corporations. Promotion and organization of corporations and the rights and liabilities of officers, directors, and shareholders. 1 unit. BAUM, FRAMPTON, MCCORD.

326. Evidence. Principles governing the competency of witnesses and the admissibility of evidence. 1 unit. MARSHALL, QUICK.

328. Income Taxation. A study of federal income tax problems relating to business and investment transactions. Subjects treated include the concept of taxable income; allowable deductions; accounting for income and deductions; capital gains; partnership operations; corporate distributions and organizations; and tax procedure. 1 unit. MCCORD, YOUNG.

329. Decedents' Estates and Trusts. A study of the gratuituous disposition of property by intestacy, by will, and by inter vivos gifts and trusts, including administration of decedents' estates and trusts. 1 unit. KIONKA, WAGGONER.

330. Restitution. Contractual and quasi-contractual remedies (both legal and equitable) available because of duress, fraud, innocent misrepresentation, mistake, illegality, and economic compulsion in the formation and discharge of contracts and other transactions. 1 unit. DUVAL.

331. Legislation. A study of legislative policies and procedures, of legislation as a source of law, of types of statutes and their structure, and of the problems of interpretation. 1 unit. COHN.

333. Persons. Creation and dissolution of the family unit and relations between members thereof; marriage, separation, divorce, rights and duties of spouses and means for their enforcement; legal capacity of wife and infant. ½ unit. KRAUSE.

334. Criminal Law Administration and Procedure. Problems in the administration of the criminal law; a study of criminal procedure from arrest to the end of the prosecution in a court of review, with emphasis on procedure as a device for social regulation, and including an appraisal of aims and workings of probation, parole, and executive clemency. ½ unit. BOWMAN, LAFAVE.

335. Trials and Appeals. Ligation from process through appeal, excluding pleading and evidence. 1 unit. MARSHALL, SEMMEL, STONE.

337. Commercial Law, II. Selected problems under the Uniform Commercial Code in modern commercial banking law and practice. ½ unit. BENFIELD.

338. Insurance. Personal and property insurance; formation of the insurance relation; concealment, warranties, representations; insurable interest; conditions; subrogation; waiver and estoppel; incontestability; the respective interests of the beneficiary, insured, insurer, asignee, and creditor, and facts constituting maturity in life, accident, fire, theft, liability, and collision policies. ½ unit. DOOLEY.

339. Conflict of Laws. Problems from conflict of laws involving jurisdiction of courts; judgments; torts and workmen's compensation; contracts; property; family law; administration of estates; business organizations; governmental activities. 1 unit. DUVAL, HAY.

340. Local Government Law. History and functions; judicial, legislative, and administrative control; creation, dissolution, and changes in structure; law-making powers; finance; planning and development functions; regulatory powers; contracts; tort liabilities; federal-local and inter-local relations. 1 unit. BAUM.

341. Oil and Gas. Nature of the property interests in oil and gas; legal interests created by oil and gas leases; validity of leases; the habendum clause; the drilling and rental clauses; transfer of oil and gas interests; rents and royalities; public regulation of the production of oil and gas. 1 unit. FINDLEY.

342. Mortgages. A study of real estate mortgages. 1 unit. FINDLEY.

343. Admiralty. Admiralty and maritime jurisdiction; the maritime lien; carriage of goods; salvage; general average; collision; claims of seamen; limitation of liability; application of state law; sovereign responsibility; choice of law. 1 unit.

344. Creditors' Rights. Remedies of the delinquent debtor and his creditors under the Bankruptcy Act; liquidation and rehabilitation; exercises in bankruptcy procedures. 1 unit. BOWMAN.

345. Civil and Political Rights. A study of some of the basic problems in the relation of the individual to government and in the protection of rights of minority groups. ½ unit. REISNER.

346. Future Interests. A study of the validity and effect of gratuitous dispositions of assests in which enjoyment is postponed, restrained, or long continued; classification of future interests; construction; powers of appointment; rule against perpetuities and related restrictions. 1 unit. WAGGONER.

347. Labor Law, I. Same as Labor and Industrial Relations 347. The law of industrial relations with special emphasis on recent cases and legislation; the establishment of the collective bargaining relationship; strikes, boycotts, and picketing; Federalism and labor relations. 1 unit. GOLDBERG.

348. International Law. The nature, sources, and subjects of international law, its place in the control of international society, and an examination of the law of jurisdiction, territory, recognition, and succession of states, rights and immunities of states in foreign courts, diplomatic immunities, treaties, protection of citizens abroad, settlement of international disputes, war and neutrality, the United Nations, and the International Court of Justice. 1 unit.

349. State and Local Taxation. Proper and improper purposes of taxation; the general property tax and its administration; taxpayers' remedies; excise taxes on business concerns and transactions; problems of jurisdiction to tax. ½ unit. YOUNG.

351. Jurisprudence. The place of law in society, the goals and methods of law, the nature of law, relation of law and social science. 1 unit.

352. Taxation of Gratuitous Transfers. Various tax problems encountered in the distribution of wealth by inter vivos and testamentary disposition, including a study of federal estate and gift taxes, the Illinois inheritance tax, problems in the assignment of income, and federal income taxes upon estates and trusts. Attention is given to tax planning in the distribution of wealth. ½ unit. KIONKA, MCCORD, YOUNG.

353. Corporation Finance and Securities. Drafting provisions of preferred shares; counseling problems requiring written memoranda on the application of state and federal securities laws to the marketing of securities and on the effect of statutes and decisions on distribution of dividends, redemption and purchase of shares, and recapitalization, reorganization, and dissolution of corporations. ½ unit. FRAMPTON, MCCORD.

355. Trade Regulation. Antitrust law, control of restrictive business practices, monopoly, unfair competition, trademarks, price discrimination, resale price maintenance, Federal Trade Commission. 1 unit.

356. Federal Courts. The federal judicial system; relationship of federal and state law; jurisdiction of federal courts and their relation to state tribunals. 1 unit. STONE.

358. Modern Social Legislation. A focus, for illustrative purposes, on the traffic victim and his claim for compensation: the present common-law method compared with various schemes of social insurance; problems of coordinating, as well as comparing, any such scheme of social legislation with the tort system and with other social and private insurance arrangements such as workmen's compensation, Blue Cross, etc. Attention is given to both broad questions of social policy and technical drafting problems. 1 unit. O'CONNELL.

359. Legal History. The development of the common-law system in England and America:

the origin and growth of English legal thought, legal doctrine, and legal institutions; the history of real property, contracts, and torts; the origin and development of courts, legislation, equity, the doctrine of precedent; the evolution of the legal profession; the reception of the common law in America. 1 unit.

365. Tax Problems. Selected problems relating to partners and partnerships, corporations and shareholders. ½ unit. McCord, Young.

369. Soviet Law. An examination of Soviet conceptions of the role of law as evidenced both in theory and in practice; emphasis on highlights of Soviet law, with comparison to the common-law and civil-law traditions; study of Soviet court and legislative materials to determine characteristic pattern with respect to: constitution and administration, the relation of the individual with the state and with society; legal regulation of property and productive institutions, private relationships, and international law. 1 unit. Maggs.

370. Labor Law, II. Advanced problems in the law of industrial relations with particular emphasis on the negotiation and administration of the collective bargaining agreement; the relation between the individual and the union. ½ unit. Prerequisite: Law 347 or consent of instructor. Goldberg.

371. Seminar in Selected Legal Problems. An introduction to the methods and materials of legal research. The work of the course consists of the discussion of selected topics. In addition, each student investigates a topic approved by the instructor. The results of the investigation are presented orally to the class and submitted in writing to the instructor. The several sections are oriented to different subject matter areas. Credit may be earned in more than one section. ½ unit.

372. Problems in Estate Planning. Selected problems in the planning of estates which serve to integrate the basic materials in property, trusts, wills, income, estate, and gift taxation. ½ unit. McCord, Young.

382. Comparative Law. A comparative analysis of the three basic institutions of private law: tort, contract, and property. The solutions arrived at in the common-law system are contrasted with the solutions arrived at in the civil-law system and in the Soviet legal system. 1 unit. Krause.

383. Law and Society. An examination of some important ideas concerning the nature of law and the role of law in society. 1 unit. Reisner.

387. International Economic Organizations. A survey of the principal international economic organizations such as GATT, OECD, ECE, and international monetary and investment institutions (IMF, IBRD, AID); an intensive study of the European Common Market, particularly of its laws relating to trade barriers, establishment of companies, and antitrust; United States legislation in the field of international trade (Trade Expansion Act of 1962). 1 unit. Hay.

399. Research in Special Topics. Individual research on a special problem selected in consultation with the instructor. ½ or 1 unit.

LIBRARY SCIENCE

The purpose of the Graduate School of Library Science is to prepare men and women for careers as professional librarians in all types of libraries. Programs of study may be followed leading to the master's degree, Certificate of Advanced Study in Librarianship, Doctor of Philosophy in Library Science, and Doctor of Library Science.

Master of Science. Applicants for admission to the Graduate School of Library Science must also be admitted to the Graduate College.

In addition to the Graduate College requirements, applicants to the Graduate School of Library Science must meet the following requirements: (1) a minimum grade-point average of 3.75 for the last sixty hours of academic work completed; (2) one sequence (two terms) of courses at the college level in each of the three main fields of science, social science, and hu-

manities, and a total of four such sequences in all; (3) a major subject in any field of study (except library science) comparable to the undergraduate major at the University of Illinois (at least twenty-four semester hours); (4) two years of college-level study of any foreign language. This may be either two years of study of one language or one year of each of two languages.

A candidate for the master's degree must complete a prescribed program of undergraduate courses. This requirement may be met by one of the following: (1) completion of a minimum of sixteen semester hours of library science with a grade-point average of at least 4.0 in an institution approved by the Graduate School of Library Science; (2) completion of the preparatory sequence of four courses, Library Science 201, 204, 255, and 258, in the Graduate School of Library Science with a grade-point average of at least 4.0. Exemption from one or more of these courses may be secured by a satisfactory score on a comprehensive examination which is offered on the day preceding the opening of registration each semester and summer session. There is a special offering of these four courses each eight-week summer session, enabling beginning students to complete the entire preparatory sequence before taking regular graduate library science courses in the fall semester. This makes possible the most efficient and satisfactory program, and students are urged to plan accordingly.

At least two semesters in residence—or the equivalent—are required to earn the master's degree, in addition to attendance in preparatory courses. In this period, eight units of graduate study should be completed. Each student's program of study, adapted to his particular needs and purposes, is planned in consultation with an adviser at the time of original registration and thereafter. Students who have completed their undergraduate library science requirement in institutions other than the University of Illinois are required to take the comprehensive examination and to complete Library Science 405, 407, and 411 or 412, and one of the 300-level literature courses. No thesis is required.

Students interested in the master's program, the Certificate of Advanced Study in Librarianship, the Doctor of Philosophy, and Doctor of Library Science should write to the Director of the Graduate School of Library Science, 329 Library. Other supplementary material is also available from this source.

FACULTY

Professors: R. B. Downs (Dean of Library Administration), H. Goldhor (Director of the Graduate School of Library Science), Frances B. Jenkins, Winifred C. Ladley, M. Alice Lohrer, R. E. Stevens.

Associate Professors: D. W. Krummel, F. W. Lancaster, Cora E. Thomassen.

Assistant Professors: W. C. Allen, T. Crowley, Kathryn L. Henderson, Carol L. Kronus.

COURSES FOR GRADUATES

402. Studies in Reading. Designed to acquaint students with the major areas of investigation and interest in reading. Special attention is given to studies of reading interests and habits of children, youth, and adults. Class discussions are devoted to analysis of various studies and their implications for library service and classroom teaching. 1 unit. Ladley, Lohrer.

405. Library Administration. Designed to supply knowledge of the internal organization of libraries and of the principles of library administration. Emphasis is on comparison of the conditions found in the several kinds of libraries and on applications of the general theory of administration. 1 unit. Prerequisite: Library Science 204 or consent of instructor.

406. Library Service to Children and Young Adults. The role, problems, and needs of library service in the elementary and secondary school fields, and of library work with children and young adults in the public library. A two-day field trip is required; estimated cost, $25.00. Credit is not given for Library Science 406 in addition to credit in Library Science 307. 1 unit. Prerequisite: Library Science 204 or 405. Ladley, Lohrer.

407. Cataloging and Classification, I. The theory, practice, and application of the principles of cataloging and classification. Emphasizes subject cataloging and complex types of entry. Problems provide experience with the Decimal Classification and Library of Congress Classification and Library of Congress subject headings. 1 unit. Prerequisite: Library Science 255 or consent of instructor. HENDERSON.

408. Cataloging and Classification, II. The theory, practice, and application of the principles of cataloging and classification. Takes up the cataloging and classification of special types of materials, including maps, music, films, slides, phonograph records, and incunabula and other rare items. Includes some discussion of the administrative problems of a cataloging department. 1 unit. Prerequisite: Library Science 407. HENDERSON.

409. Communication Roles and Responsibilities of Libraries. Mass media of communication are considered in terms of their relations with modern library services: media organization, content, and research are reviewed; problems of intellectual freedom are considered as an aspect of communications behavior; and the potential role of electronic devices in library activities now and for the future is discussed. 1 unit.

410. Adult Education and Libraries. The literature, history, and problems of adult education in the United States are presented in relation to the role of the library as an educational agency. Students study organization for adult education in the community and become familiar with the significant methods and materials used in a variety of educational programs. 1 unit. BONE.

411. Reference Service in the Humanities and Social Sciences. Detailed consideration of the bibliographical and reference materials in various subject fields, with training and practice in their use for solving questions arising in reference service. 1 unit. Prerequisite: Library Science 201 or consent of instructor. ALLEN, STEVENS.

412. Science Reference Service. Study of representative reference sources in pure and applied science. Designed to acquaint the student with typical problems encountered in providing and servicing scientific reference materials. 1 unit. Prerequisite: Library Science 201 or consent of instructor. JENKINS.

415. Library Mechanization and Automation. Introduces various types of equipment for handling information and providing services in libraries; studies applications to library operations; includes introduction to systems planning, to automation concepts, and to computer use. 1 unit. Prerequisite: Library Science 201, 204, 255, and 258, or consent of instructor.

424. Government Publications. The nature and scope of American and British government publications; the problems of organization arising from their form and from the methods of their production and distribution. 1 unit. Prerequisite: Library Science 411 or 412, or consent of instructor.

427. Resources of American Research Libraries. Aims to acquaint students with the distribution and extent of American library resources for advanced study and research; spatial and financial aspects of library resources; methods of surveying library facilities; growth and use of union catalogs and bibliographical centers; interinstitutional agreements for specialization of collections and other forms of library cooperation; and the use by the scientist and scholar of the research collection. S; 1 unit. STEVENS.

428. Library Buildings. A study of the library's physical plant in the light of changing concepts and patterns of library service. Present-day library buildings, both new and remodeled, are analyzed and compared with each other as well as with buildings of the past. The interrelationship of staff, collections, users, and physical plant is examined in detail. Class discussion is supplemented by visits to new libraries and conference with their staffs. A two-day field trip is required; estimated cost, $25.00. 1 unit. Prerequisite: Library Science 405 or consent of instructor. ALLEN.

429. Information Storage and Retrieval. Analyzes the problems which confront libraries and library users as a result of the growth of literature; reviews the various systems for storing and retrieving information; introduces the underlying models and basic types of

equipment for both traditional and non-conventional systems; emphasizes practical applications in libraries. 1 unit. Prerequisite: Library Science 415; consent of instructor. LANCASTER.

430. Advanced Reference. Designed to enable the student to utilize the varied resources of a large research library. Deals with the methods of analyzing and solving bibliographic problems such as arise in scholarly libraries and in connection with research projects. 1 unit. Prerequisite: Library Science 424 or consent of instructor. ALLEN.

431. Books and Libraries in the Ancient and Medieval World. The development of writing and of the book in ancient and medieval times; book collecting and the growth of libraries from earliest times to the discovery of printing. 1 unit. STEVENS, KRUMMEL.

432. Books and Libraries Since the Renaissance. Same as Communications 432. The study of the developing format of the book, the history of printing, and the growth of libraries in Europe and America since the Renaissance. 1 unit. KRUMMEL, STEVENS.

433. Advanced Subject Bibliography. A study of the literature, information sources, and reference aids in various specialized fields of knowledge, identified as different sections of this course, from the point of view of their use by librarians. No student may take more than two different sections for credit toward a degree: (b) biological sciences, (c) chemistry, (d) education and psychology, (e) engineering, (g) law, (h) maps, (i) music, (j) Slavic bibliography. ½ unit. Prerequisite: Consent of instructor. STAFF.

434. Library Systems. Considers the development of library systems, with special reference to public libraries as a norm for the development of library services: library standards, the growth and development of county and regional libraries, the role of the state library and of federal legislation are among the topics treated in detail. 1 unit. Prerequisite: Library Science 405 or consent of instructor. CROWLEY.

436. Development of the Library Catalog. The history and philosophy of classification schemes and cataloging codes, and comparative study of present-day cataloging practices. 1 unit. Prerequisite: Library Science 407, 408, or consent of instructor.

438. Administration and Use of Archival Materials. Administration of archives and historical manuscripts, with emphasis on the processing and research use of archival materials. 1 unit. Prerequisite: Consent of instructor. BRICHFORD.

439. Medical Literature and Reference Work. Considers representative reference and bibliographical aids in medical sciences. Problems provide experience with typical medical reference sources (only at the University of Illinois Medical Center in Chicago). S; 1 unit. Prerequisite: Consent of instructor. MECKEL.

440. Problems in Bibliographical Method. Same as English 450. Work on individual bibliographical problems, with a study of bookmaking, manuscripts and their relation to the printed text, editorial problems, and literary forgeries. 1 unit. Prerequisite: Consent of instructor. ALLEN.

441. History of Children's Literature. Interpretation of children's literature from the earliest times to the present, with recognition given to the impact of the changing social and cultural patterns on books for children and on children's reading. Attention is given to the early printers and publishers of children's books and to magazines for children in the nineteenth century. 1 unit. LOHRER.

442. Seminar in Library Materials for Children and Young Adults. Advanced study of the criteria for the evaluation of books, films, and recordings. Each student completes a project on a given theme or subject, involving extensive and critical reading, viewing, and listening. 1 unit. Prerequisite: Library Science 303 or 304, and Educational Psychology 211, or consent of instructor. LADLEY.

443. Contemporary Book Publishing. Survey of twentieth-century book publishing, particularly in America, placing it in an economic, social, and literary context. Emphasis is on production, technological developments, economic structure, methods of distribution and promotion, and book publishing as an art. 1 unit. ALLEN.

COURSES FOR ADVANCED GRADUATES

450. Advanced Studies in Librarianship. Directed and supervised investigation of selected problems in library resources, reference service, research libraries, reading, public libraries, or school libraries. $\frac{1}{2}$ to 2 units. Prerequisite: Fifth-year degree in library science or consent of director. STAFF.

460. Special Topics in Librarianship. An advanced seminar on topics of individual choice; presentation and criticism of written research reports based on individual study on an advanced level. Students may enroll in a maximum of two sections, concurrently or consecutively. Open to doctoral students only. 1 unit. Prerequisite: Consent of instructor. STAFF.

462. History of Education for Librarianship. A study of the origin and development of library science education in this country and abroad; emphasis is placed on the major events and activities which led to the present status of library school programs. 1 unit. Prerequisite: Master of Science in Library Science or consent of instructor.

465. Librarianship and Society. Analysis of the role and functions of libraries in the twentieth century; the changing characteristics of information and knowledge are viewed as major determinants of libraries' relations to society. 1 unit. Prerequisite: Master of Science in Library Science or consent of instructor. KRONUS.

468. Teaching Methods and Special Problems in Contemporary Library Schools. Designed for those interested in preparing for the teaching of library science at the graduate level. Current library school programs and the various methods of instruction are analyzed as to effectiveness and application for the major areas of library science content; attention is given to the process of curriculum construction to meet the changing needs of the profession and to the experience of other professions. 1 unit. Prerequisite: Library Science 462 or consent of instructor. GOLDHOR.

469. Principles of Research Methods. Designed for persons planning to engage in research. The course reviews significant investigations in the library field, and considers the use of hypotheses, the conduct of experiments, the nature of proof, and the employment of statistical methods, with a view to helping students develop their dissertations. Required for Ph.D. candidates. 1 unit. Prerequisite: Knowledge of the principles of statistics, Master of Science in Library Science, or consent of instructor. GOLDHOR, KRONUS.

499. Thesis Research. Individual study and research. Section A: M.S. candidates, 0 to 2 units. Section B: Doctoral candidates, 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Literature of the Humanities and Social Sciences. This course is designed to build a knowledge of the scope and significant characteristics of the several fields comprising the humanities and social sciences through a systematic study of names, trends, and outstanding classic and current materials in each. Attempts to identify general basic knowledge for each field which is essential for the librarian in selection of materials and reading guidance. 1 unit. BONE.

302. Literature of the Sciences. An introduction to the scope and significant characteristics of the literature of science, to modern concepts and representative literary works in each of the major fields of pure and applied science. Designed to give an insight into the content of the scientific disciplines and of their role in modern society. Selected readings and films acquaint students with representative material in the field. 1 unit. Prerequisite: Library Science 204, 258, or consent of instructor. JENKINS.

303. Library Materials for Children. The selection and use of library materials for children in public and school libraries, according to the needs of the child in his physical, mental, social, and emotional development and the purposes of the elementary school program. The student becomes acquainted with the standard selection aids for children

and with all types of printed and audio-visual materials, and develops the ability to select and describe children's library materials according to their developmental uses. Credit is not given for Library Science 303 in addition to credit in Library Science 307. ½ or 1 unit. LADLEY, LOHRER, THOMASSEN.

304. Library Materials for Young Adults. The selection and use of library materials for the young adult in school and public libraries and community organizations. The course aims to develop the ability to select and evaluate a wide variety of reading materials from standard bibliographies for the adolescent according to his personal and school needs. Credit is not given for Library Science 304 in addition to credit in Library Science 307. ½ to 1 unit. LOHRER, THOMASSEN.

307. Library Materials and Services for Children and Young Adults. A nonspecialist's view of the materials and services involved in work with children and young adults, including a brief survey of print and nonprint materials for children and young people, and basic guidelines for library services to them. Credit is not given for Library Science 307 in addition to credit in Library Science 303, 304, 309, or 406. 1 unit. THOMASSEN.

308. Audio-Visual Services in Libraries. Designed to acquaint students with the typical audio-visual programs and responsibilities of libraries. Group activities stress, through presentation and evaluation, the use of materials and related equipment necessary for film, radio and television, exhibit, and other programs of libraries. The practices of audio-visual departments in libraries are reviewed and evaluated. A two-day field trip is required; estimated cost, $25.00. 1 unit. THOMASSEN.

309. Storytelling. Fundamental principles of the art of storytelling including techniques of adaptation and presentation. Content and sources of materials; story cycles; methods of learning; practice in storytelling; planning the story hour for the school and public libraries, for recreational centers, for the radio, and for television. Open to undergraduates and non-Graduate School of Library Science students. Credit is not given for Library Science 309 in addition to credit in Library Science 307. ½ or 1 unit. Prerequisite: Library Science 303 or consent of instructor. LADLEY.

310. Typographic Disciplines of the Book. Same as Journalism 310 and English 392. The study of the book as a manufactured object, with emphasis upon practices and methods in continuous use from the Renaissance to the present, including type faces, paper, binding, and illustration. Extensive practicum in the typographic laboratory. ½ unit. Prerequisite: Consent of instructor. CHAPDU.

354. Audio-Visual Communication. Same as Elementary Education and Secondary and Continuing Education 354. An analysis and application of those introductory aspects of communication theory and practices concerned with the design and use of audio-visual messages which influence the learning process. This course is also concerned with selection, utilization, production, and evaluation of audio-visual materials and selected technological aids. ½ or 1 unit. Prerequisite: Senior or graduate standing. ISAACS.

LIFE SCIENCES

(Including Biology, Botany, Entomology, Microbiology, Physiology and Biophysics, and Zoology)

The School of Life Sciences includes the departments of Botany, Entomology, Microbiology, Physiology and Biophysics, and Zoology. Study programs leading to the graduate degrees of Master of Science and Doctor of Philosophy exist in each of the departments and are described in detail in the following pages. Interdepartmental study programs leading to advanced degrees in cell biology and virology, environmental biology, neurosciences, and plant physiology are administered within the School. The School also participates with other departments of the University in offering the Ph.D. program in genetics (see page 208) and with the Department of Chemistry and Chemical Engineering in offering a program in bio-

physical chemistry (see page 117). Applicants who desire to enter any of the graduate study programs are usually required to have earned a grade-point average of at least 4.0 for their last sixty hours of undergraduate work. In certain programs, applicants with a grade-point average between 3.5 and 4.0 are considered by a special committee.

Support for graduate training is available in the form of teaching or research assistantships, University fellowships, or trainee fellowships. Prospective students may obtain application forms and relevant information for departmental study programs from the executive officer of the appropriate department, or for interdepartmental study programs from the Director of the School of Life Sciences.

INTERDEPARTMENTAL STUDY PROGRAM

Master of Science in the Teaching of the Biological Sciences and General Science. This degree is offered with the completion of the fifth year in the teacher-education curriculum in biological and general science. The degree is primarily intended for but not restricted to certified teachers of biology and general science in junior high school, high school, and junior college. For admission to this degree program, students must have a grade-point average of at least 3.5. See pages 36 and 37.

Candidates for the Master of Science in the Teaching of the Biological Sciences and General Science must earn four units in biological sciences, two units in education, and two units in electives. The two units in education must include: History and Philosophy of Education 304 and 305, one unit; and Educational Psychology 311 and 312, one unit. Electives may be in the biological sciences, in education, or, in exceptional cases, in other fields. A course in biological chemistry is strongly advised. Students who are preparing for high school teaching and who are not yet certified must fulfill state certification requirements. The adviser for candidates for this degree is Professor Joseph Larsen, 393 Morrill Hall.

Master of Science in Biology. The program of study leading to the master's degree in biology is designed for individuals who do not wish to limit their training to a single area of biology. Students whose interests fall into a specific area of biology should apply directly to the relevant department or program.

Admission to this curriculum requires a grade-point average of 4.0 or higher. Applicants whose grade-point average is less than 4.0 but 3.75 or higher are considered on an individual basis. Those in the latter group should outline their educational objectives in a brief statement and should, in addition, submit three letters of recommendation. Although no specific undergraduate courses are required for admission to this curriculum, a year of physics, a course in organic chemistry, and a semester of calculus or statistics must be completed before a degree is granted. Preference is given to those applicants who have already completed most of these courses.

Candidates for the degree are advised to obtain a broad, basic training in biology and are examined in aspects of cellular, genetic, organismic, and population biology. Of the eight units required for the degree, at least two units must be taken in 400-level courses. A thesis is not required, but at least one unit of individual problem work must be included. A comprehensive examination is required of all candidates for the degree.

Doctor of Philosophy in Biology. The School of Life Sciences offers Ph.D. programs in several interdepartmental areas: cell biology and virology, environmental biology, neurosciences, and plant physiology. Entrance requirements, in addition to those listed above, for the M.S. program, include background training in general biology, physics, biochemistry, and calculus, but deficiencies in these areas may be remedied during the first year of graduate study. Study programs are designed to suit individual needs in consultation with advisers. Descriptions of the area programs are given below.

Students who have been accepted for one of these programs may select any faculty member in the School of Life Sciences, or an appropriate member of a cooperating department as a major adviser. Additional information may be obtained from the Director of the School of Life Sciences.

CELL BIOLOGY AND VIROLOGY

The cell biology and virology program emphasizes molecular mechanisms and is therefore addressed to students who have acquired or wish to acquire a strong background in chemistry. Areas of research open to students in this program include cytochemistry, biochemistry of subcellular systems, cellular differentiation, intercellular regulation of meiosis and mitosis, circadian rhythms, cellular genetics, and virology.

ENVIRONMENTAL BIOLOGY

The environmental biology program emphasizes a multidisciplinary approach to the study of the effects of environmental quality on living organisms. Areas of research specialization include animal, plant, and human ecology; physiological and population ecology; population genetics and systematic biology; limnology, ethology, zoonoses, and applied ecology.

GENETICS

See page 208.

NEUROSCIENCES

The program in neurosciences is interdepartmental, and its staff includes psychologists, physiologists, biochemists, and ethologists. The program emphasizes physiological psychology, animal behavior, biochemistry, physiology of axons, synapses and higher nervous systems. Research areas include neurochemistry, ethology, cybernetics, comparative and mammalian neurophysiology, neuroanatomy, and physiological psychology.

PLANT PHYSIOLOGY

Plant physiology is an interdepartmental area of specialization coordinated under the biology program. The program is staffed by plant physiologists from the five plant science departments (Agronomy, Botany, Forestry, Horticulture, and Plant Pathology). Thesis research can be conducted in any of these departments. Areas of research include photosynthesis, respiration, membrane transport, nitrogen, herbicide action, water relations, and environmental physiology. In addition to plant physiology, students are required to complete courses in biochemistry and physical chemistry.

Biology

The following courses are administered directly by the School of Life Sciences. These courses, as is the case with departmental courses, are applicable to the study programs within the School.

COURSES FOR GRADUATES

405. Methods of Taxonomy. A survey of basic procedure and techniques utilized in zoological classification. Major topics are assembly and arrangement of zoological materials, use of the fundamental taxonomic literature, descriptive and inferential statistical methods, data processing, and the interpretation and presentation of results and investigations. $\frac{3}{4}$ unit. Prerequisite: Biology 305 or equivalent; a course in statistics.

409. History of Biology. The development of biological concepts from the classical Greek period to the present. 1 unit. Prerequisite: Consent of instructor.

411. Discussions in Genetics and Cytogenetics. $\frac{1}{4}$ unit.

412. Analysis and Control of Natural Environments. Discussion and analysis of physiological, biochemical, and ecological aspects of environmental quality. Emphasis is placed on the detection and characterization of environmental pollution, on the con-

servation of environmental quality, and on the applied ecology of the control of plant and animal populations. $^3/_4$ unit. Prerequisite: Biology 312 or consent of instructor.

418. Concepts and Topics in Immunology. Same as Veterinary Medical Science 418. Newer concepts and theories in the field of immunology, including theories of antibody formation and immunologic tolerance, regulation of the immune response, biosynthesis and structure of antibodies, and evolutionary aspects of the immune response. Lectures and discussion. $^1/_2$ unit. Prerequisite: Consent of instructor. Microbiology 327 and Biology 307 recommended.

423. Electron Microscopy. Same as Chemistry 423. Lectures, discussions, and demonstrations on the physical principles and electron optics of the transmission electron microscope and its modern variants, including lectures and demonstrations of modern high vacuum techniques. Open to qualified graduate students in all departments. $^1/_2$ unit. Prerequisite: A course in modern physics or physical chemistry (having calculus as a prerequisite) affording an introduction to wave mechanics, or consent of instructor.

429. Electron Microscopy with Laboratory. Same as Chemistry 429. General lectures on theory and design of electron microscopes without mathematical derivations; discussion and practice on specimen preparation; operation of electron microscopes with separate sections to meet special needs of biologists, geologists, and those interested in electron diffraction. Most theory lectures may be omitted by those enrolled or having credit in Biology or Chemistry 423. Open to qualified graduate students in all departments. 1 unit. Prerequisite: Two semesters of general physics, two semesters of college mathematics, and three semesters of chemistry; or consent of instructor.

430. Biological Ultrastructure. Lectures and reports on the fine structure of plant and animal cells and cell products with discussions of possible relationships of ultrastructure to function and of diverse interpretations of chemical-physical information as ultrastructure. Offered in 1971-1972 and in alternate years. 1 unit. Prerequisite: Consent of instructor.

440. Advanced Plant Physiology, I. A comprehensive presentation of current knowledge in plant physiology. First semester of a two-semester sequence covering cell organization and function, respiratory and photosynthetic mechanisms, transport processes, nutrition, biosynthesis, growth, development and reproduction. 1 unit. Prerequisite: Chemistry 350 and 355; Botany 330 and 335; or consent of instructor.

441. Advanced Plant Physiology, II. A comprehensive presentation of current knowledge in plant physiology. Second semester of a two-semester sequence covering cell organization and function, respiratory and photosynthetic mechanisms, transport processes, nutrition, biosynthesis, growth, development and reproduction. 1 unit. Prerequisite: Biology 440.

490. Special Topics in Biology. Individual topics in research and/or reading conducted under the supervision of faculty members in the School of Life Sciences. This course is particularly designed for students enrolled in the biology program who would like to become more familiar with specialized fields of study prior to committing themselves to a specific area for their doctorate degree. $^1/_2$ to 2 units.

493. Advanced Electron Microscopy. Conferences and practice dealing with specialized laboratory techniques, preparation of specimens, and the analysis and study of varied materials by use of transmission and/or scanning electron microscopes, and by the techniques of electron diffraction. Open to qualified students in all departments. $^1/_4$ or $^1/_2$ unit. Prerequisite: Biology or Chemistry 429; consent of instructor.

499. Thesis Research. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

305. Principles of Taxonomy. A discussion of the development and current status of the principles of taxonomy in general, together with a detailed consideration of the evolu-

tionary processes producing animal taxa and the phylogenetic and statistical concepts pertinent to their classification. 3/4 unit. Prerequisite: Biology 210 or equivalent.

307. Immunology. Introductory course in the fundamentals of immunology with emphasis on biological application; designed to give a basic background for understanding immunological responses with an introduction to techniques applicable to biological research. 3/4 unit. Prerequisite: Four semesters of college biology; Chemistry 133 or 234 or consent of instructor.

308. Experimental Immunobiology. An introduction to laboratory techniques employed in immunological investigations. Laboratory. 1/2 unit. Prerequisite: Credit or registration in Biology 307; consent of instructor.

309. Population Biology Laboratory. A laboratory designed to complement and exemplify certain concepts in population ecology and genetics, ethology, community ecology, and biometrics as discussed in Biology 310-311. Laboratory experiments and field observations; one or two Saturday morning field trips. 1/2 unit. Prerequisite: Credit or registration in Biology 310, or consent of instructor.

310. Principles of Population Biology, I. The sequence Biology 310 and 311 provides an integrated treatment of population concepts in biology. Major topics covered include: ecology, ethology, population genetics, and evolution. 3/4 unit. Prerequisite: Biology 210 or consent of instructor; college algebra. Dawson, Willson.

311. Principles of Population Biology, II. Continuation of Biology 310. 3/4 unit. Prerequisite: Biology 310 or consent of instructor.

312. Environmental Biology. Lecture, laboratory, and field course dealing with relation of organisms to their environments and physiological bases for responses, adaptations, and behavior. Introduction of ecosystems, biotic communities, and population dynamics. Emphasis on man and his interactions with environment. 1 unit. Prerequisite: One year of biology or consent of instructor.

351. Population Biology. A study of problems associated with the behavior of plant and animal populations based on genetic, evolutionary, and ecological principles. 1 unit. Prerequisite: Biology 151 and 251, or consent of instructor.

371. Quantitative Biology. Theory and practical application in biology of probability and statistics. Lectures and assigned problems. 1 unit. Prerequisite: College algebra; consent of instructor.

DEPARTMENTAL STUDY PROGRAMS AND COURSES

Botany

The Department of Botany offers graduate work leading to the Master of Science and Doctor of Philosophy degrees. All applicants for admission are considered on an individual basis. It is desirable that applicants have had some undergraduate training in botany or biology and related sciences. Applicants should have a minimum grade-point average of 4.0 (on a 5.0 scale), but those with averages between 3.75 and 4.0 are also considered.

The following subjects comprise a partial listing of areas of specialization available within the department: anatomy, cytology, ecology, genetics, morphogenesis, mycology, paleobotany, photosynthesis, phycology, physiology, systematics, and virology. Students who work with members of the botany faculty may also choose from the interdepartmental degree programs, including cell biology and virology, biophysics, genetics, and plant physiology. Each of these areas has well-equipped facilities for graduate student research. The department's laboratories and growth chambers are in a new, air-conditioned building, with herbarium and greenhouses situated close by. Graduate students have access to a wide variety of research tools ranging from analytical centrifuges and electron microscopes to a herbarium of 500,000 specimens and a new paleobotany laboratory with an outstanding collection of teaching and research materials. Nearby facilities available for field research include University-owned

woodlands, prairie, and farmland; in southeastern Illinois, the University maintains a large experiment station. Among other noteworthy campus facilities are computer services, a central electron microscope laboratory, and an excellent biological sciences library.

Graduate students are expected to acquire reasonable breadth in their botanical backgrounds as well as depth in their areas of specialization. Botany comprises many disciplines and a knowledge of the principles of ecology, genetics, morphology, pathology, physiology and systematics, for example, is of great importance. It is anticipated that most new students will arrive with training in some of these areas, and that all students will continue to round out their education as they earn advanced degrees.

Master of Science. Candidates for this degree are expected to fulfill the requirements of the Graduate College (see pages 35 to 37) and to broaden and deepen their training in a program of course work agreed upon with a faculty adviser. A thesis may be required for the Master of Science degree at the option of the candidate's adviser.

Doctor of Philosophy. Candidates for this degree are expected to fulfill the requirements of the Graduate College (see pages 37 to 39) in a program of course work and research under the supervision of a faculty adviser.

As each student nears completion of his first eight units of graduate study, three or more faculty members (other than the student's adviser) who are expected to serve on the Ph.D. preliminary examination committee evaluate his progress toward the Ph.D. These committee members have the responsibility of making recommendations to the student and his adviser on whether or not the student should be allowed to continue for the Ph.D. degree, and on the content of the remaining portion of the student's graduate program. Candidates who enter with a master's degree from another institution are required to meet with their committee members as soon as possible after they have chosen an adviser.

FACULTY

Professors: J. B. Hanson (Head of Department), L. M. Black, J. M. deWet, Govindjee, G. N. Jones, J. R. Laughnan, J. F. Nance, M. E. Reichmann, D. P. Rogers, D. M. Steffensen.

Associate Professors: Z. B. Carothers, D. K. Cox, D. B. Dickinson, L. R. Hoffman, W. W. Payne, T. L. Phillips, C. Sybesma, R. W. Tuveson.

Assistant Professors: C. J. Arntzen, F. A. Bazzaz, J. S. Boyer, A. W. Haney, R. MacLeod, M. L. Sargent.

COURSES FOR GRADUATES

402. Molecular Genetics. See Zoology 402. $\frac{3}{4}$ unit. Prerequisite: Microbiology 330 or equivalent. Hershberger.

403. Physiology of Fungi. Same as Plant Pathology 403. The germination, growth, metabolism, and sporulation of fungi; physiology of the fungi as related to parasitism, antibiotic production, vitamin assay, and industrially important products. The nature of fungicidal activity is discussed. Offered in 1971-1972 and in alternate years. 1 unit. Prerequisite: Organic chemistry or biochemistry; mycology, plant pathology, or microbiology. Gottleib.

405. Microbiological Genetics. See Microbiology 405. $\frac{3}{4}$ unit. Prerequisite: Microbiology 330; mathematics through calculus, or consent of instructor. Woese.

410. Botany Discussions. All graduate students in botany, except those with conflicting teaching assignments, are required to register in and attend the general seminar. No credit is given except to those students presenting the results of their Ph.D. thesis research. 0 or $\frac{1}{4}$ unit. Staff.

413. Discussions in Plant Physiology. $\frac{1}{4}$ unit. Staff.

414. Discussions in Plant Morphology and Taxonomy. $\frac{1}{4}$ unit. Staff.

418. Discussions in Plant Ecology and Plant Geography. Developments in ecology and plant geography, with emphasis on one special division. $\frac{1}{4}$ unit; total credit is limited

to 1½ units. Prerequisite: Graduate standing in botany, entomology, geography, or zoology. Bazzaz, Haney.

419. Discussions in Photosynthesis and Related Topics. ¼ unit. Prerequisite: Consent of instructor. Govindjee.

421. Cytogenetics. Same as Zoology 421. Chromosome theory: the structure, behavior, and physiology of chromosomes in heredity and development. 1 unit. Prerequisite: Biology 210, or Microbiology 330, or consent of instructor. Steffensen.

424. Mineral Nutrition of Plants. Same as Agronomy and Horticulture 424. A study of the uptake, transport, and metabolic utilization of mineral nutrients by plants. The scope of the course is to present the essentiality of various anions and cations in the light of metabolic activity and constituency in functional plant compounds. Major emphasis is placed on metabolic activity and function of the elements. 1 unit. Prerequisite: Botany 330 or consent of instructor. Hageman.

427. Discussions in Mycology. A seminar course designed for discussion of current research activities in the morphology, taxonomy, and physiology of fungi, especially the nonparasitic forms. ¼ unit. Prerequisite: Consent of instructor. Rogers, Tuveson.

433. Advanced Physiology of Growth, Responses, and Reproduction. 1 unit. Prerequisite: Botany 330 or equivalent. Dickinson, McCollum, Nance, Wilson.

436. Advanced Plant Physiology: Photosynthesis. Same as Agronomy 436. A lecture and laboratory course dealing with physiological, biochemical, and biophysical aspects of photosynthesis. 1 unit. Prerequisite: One year each of college biology, chemistry, and physics, or consent of instructor. Govindjee, Ogren.

442. Environmental Plant Physiology. Same as Agronomy 442. A lecture course dealing with the interaction of plants and environment at the level of the whole organism, extending to the cell and the community. Heat and mass transfer, plant and soil potentials, and the effects of light on growth are emphasized. ¾ unit. Prerequisite: Chemistry 133, general physics, general or plant physiology, and consent of instructor. Boyer.

443. Environmental Plant Physiology Laboratory. Same as Agronomy 443. A laboratory course illustrating quantitative techniques for studying the response of whole plants to environment. Experiments are designed to illustrate methods of gas analysis and advanced techniques for measuring energy balance, potentials, and matter flow through plants. ¾ unit. Prerequisite: Chemistry 133, general physics, general or plant physiology, and consent of instructor; credit or registration in Botany 442. Boyer.

450. Phycology. Morphology, physiology, genetics, taxonomy, and ecology of algae. 1 unit. Prerequisite: One year of botany or another biological science, or consent of instructor. Hoffman.

460. Advanced Taxonomy of Flowering Plants, I. Phylogenetic study of flowering plants; relationship of the principal orders and families; problems of nomenclature; identification of specimens. Offered in 1971-1972 and in alternate years. ½ or 1 unit. Prerequisite: Botany 260 or one year of botany or another biological science, or consent of instructor. Payne.

461. Advanced Taxonomy of Flowering Plants, II. The application of cytology, ecology, genetics, and morphological analyses to the study of evolution and the natural relationships of populations as exemplified by species of higher plants. Offered in 1970-1971 and in alternate years. 1 unit. Prerequisite: Botany 260 and Biology 210, or equivalent; consent of instructor. Seigler.

462. Origin of Variation in Plants. Same as Agronomy 462. A study of the principles of plant evolution. Theoretical and descriptive aspects of origin of variation, mode of speciation, role of hybridization, natural and artificial selection, and adaptation are discussed. 1 unit. Prerequisite: Consent of instructor. deWet.

471. Advanced Mycology: Special Groups. The several classes of fungi and their activities are considered in successive semesters. Special groups within these classes may be selected

for concentrated study, depending upon the student's interest in mycology. $^1_2$ unit Prerequisite: Botany 372 or consent of instructor. ROGERS.

482. Ecological Methods. Field and laboratory methods used in ecology. Offered in 1971 1972 and in alternate years. 1 unit. Prerequisite: One year of botany including Botany 381 or equivalent. BAZZAZ, HANEY.

485. Plant Geography of North America. Study of principles of plant geography, plan distribution in relation to environment, and vegetational units of North America Offered in 1971-1972 and in alternate years. 1 unit. Prerequisite: Botany 381 or equiva lent. BAZZAZ, HANEY.

493. Advanced Studies in Botany. $^1_2$ to 2 units. Not more than one unit may be applied toward the Graduate College master's degree requirement of three units of course work at the 400 level. Work may be taken in the following fields:

(a) Anatomy. CAROTHERS.
(b) Biochemical Cytology. STEFFENSEN.
(c) Biological Rhythms. SARGENT.
(d) Cytogenetics and Speciation. DEWET.
(e) Ecology. BAZZAZ, HANEY.
(f) Genetics. COX, LAUGHNAN, SARGENT, TUVESON.
(g) Morphogenesis. SARGENT.
(h) Morphology. CAROTHERS, PHILLIPS.
(i) Mycology. ROGERS, TUVESON.
(j) Paleobotany. PHILLIPS.
(k) Photosynthesis. ARNTZEN, GOVINDJEE, SYBESMA.
(l) Phycology. HOFFMAN.
(m) Physiology. BOYER, DICKINSON, GOVINDJEE, HANSON, NANCE.
(n) Taxonomy. JONES, PAYNE, SEIGLER.
(o) Ultrastructure. CAROTHERS, HOFFMAN.
(p) Virology. BLACK, MCLEOD, REICHMANN.

499. Thesis Research. Individual work under supervision of members of the staff in their respective fields. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Individual Topics. For seniors and first-year graduate students who wish to study individual problems and topics not assigned in other courses. Graduate students may not offer more than one unit in Botany 300 toward a master's degree. $^1_4$ or $^1_2$ unit. Prerequisite: Botany 100; ten hours of advanced work in botany or another biological science. STAFF.

304. General Plant Morphology. A lecture and laboratory course dealing with the structure, reproduction, and evolution of representative algae, fungi, bryophytes, pteridophytes, gymnosperms, and angiosperms. 1 unit. Prerequisite: Botany 100, or Biology 110 and 111, or Biology 100 and 101, or Biology 151 and 251, or consent of instructor. CAROTHERS, ROGERS.

305. Comparative Morphology—Embryophytes. A lecture and laboratory course dealing with the development, structure, reproduction, and evolution of bryophytes, with the development, structure, reproduction, and evolution of bryophytes, lower vascular plants, and gymnosperms, with an introduction to angiosperms. One or two field trips. 1 unit. Prerequisite: Botany 100 or equivalent. PHILLIPS.

325. Paleobotany. Same as Geology 325. The structure, phylogeny, and geological distribution of representative fossil plants. Two or three field trips. 1 unit. Prerequisite: Botany 100 or Biology 100 and 101, and Geology 101; or consent of instructor. PHILLIPS.

330. Plant Physiology. A general course concerned with plant functions including water relations, mineral nutrition, metabolism, growth, and reproduction. $^1_2$ unit. Prerequi-

site: Chemistry 133 and Botany 100, or Biology 110 and 111, or Biology 100 and 101, or Biology 151 and 251. Boyer, Govindjee, Nance.

331. Experimental Cytology. Same as Zoology 331. Organization of cells of higher organisms with emphasis on the relationships between structure and function. The laboratory stresses modern cellular techniques. 1 unit. Prerequisite: Biology 151, 210, or 251; consent of instructor. Davenport, Steffensen.

335. Plant Physiology Laboratory. A laboratory course in plant physiology. A supplement to Botany 330; serves the needs of those interested in acquiring familiarity with techniques of plant physiology. ½ unit. Prerequisite: Credit or registration in Botany 330 or equivalent. Dickinson, Nance.

340. Histological Technique. Survey of techniques used in the preparation of plant tissues for microscopical examination. 1 unit. Prerequisite: One year of botany or ten hours of zoology; consent of instructor.

341. Field Ecology. Study of plant communities in various sections of North America during spring vacation (trips rotate on a three-to-five year basis); outdoor cooking and camping; transportation in University cars. ¼ unit; may be repeated for a maximum of ¾ unit. Prerequisite: One of the following—Botany 260, 366, 381, 385; consent of instructor. Haney.

345. Plant Anatomy. Study of the internal structure of vascular plants, with special emphasis on development, function, and evolutionary history. 1 unit. Prerequisite: One year of botany. Carothers.

351. Viruses, I. Same as Microbiology and Zoology 351. The study of viruses emphasizing the bacteriophages; statistical, physical, biological, and chemical properties of viruses; analysis of host-virus interactions and of viral genetics. ¾ unit. Prerequisite: Organic chemistry; biochemistry and calculus recommended. Drake.

352. Viruses, II. Same as Microbiology and Zoology 352. Extension of the principles developed in Botany, Microbiology, or Zoology 351 to the study of special plant, animal, and bacterial virus systems. ¾ unit. Prerequisite: Botany, Microbiology, or Zoology 351 or consent of instructor; biochemistry and calculus recommended. Black, Reichmann.

366. Field Botany. Identification and classification of native and naturalized flowering plants of eastern North America. S; ½ or 1 unit. Prerequisite: One course in botany; consent of instructor. Staff.

372. General Mycology. Structure, classification, and identification of fungi, including those of economic importance. 1 unit. Prerequisite: One year of botany, entomology, microbiology, or zoology. Rogers.

381. Plant Ecology. Principles of ecology, exemplified by vegetation and environments of Illinois. 1 unit. Prerequisite: Botany 260 or equivalent. Bazzaz.

Entomology

The Department of Entomology offers graduate work leading to the Master of Science and Doctor of Philosophy. Admission requires a grade-point average of at least 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

Previous training in entomology is not essential. It is recommended that students who intend to study for advanced degrees in entomology gain a thorough grounding in the fundamentals of physical and biological science, mathematics, and the liberal arts.

Master of Science. A candidate for this degree is required to demonstrate competence in insect bionomics, control, morphology, physiology, and taxonomy. This may be done by completing with a grade of B or better courses in the following series: Entomology 302, The Classification of Insects; 319, Insect Control, or 420, Insect Toxicology; 322, Insect Bionomics; 410, Insect Morphology; and 422, Insect Physiology; by passing examinations in

these subjects; or by a combination of these methods. Proficiency examinations are given by the department in the week before each semester begins. Electives, including thesis research, make up the balance of the eight-unit requirement. If research credit is presented, a thesis is required.

Doctor of Philosophy. A candidate for this degree must satisfy the requirements for the Master of Science in Entomology. The rest of the candidate's program is determined in consultation with his adviser and representatives of the department or departments in which the minor courses are taken. All minor credit must be earned outside the Department of Entomology. The minor or minors are generally selected from the biological and physical sciences.

The chief areas of specialization in the department are behavior, bionomics, economic entomology, medical entomology, morphology, physiology, taxonomy, and toxicology. The facilities of both the department and the State Natural History Survey are available for advanced study in these areas.

FACULTY

Professors: J. R. Larsen (Head of Department), G. Fraenkel, S. Friedman, W. R. Horsfall, E. R. Jaycox, C. W. Kearns, W. H. Luckmann, R. L. Metcalf, R. B. Selander, L. J. Stannard, J. G. Sternburg.

Associate Professors: A. W. Ghent, E. G. Macleod, G. P. Waldbauer, Judith H. Willis.

COURSES FOR GRADUATES

410. Insect Morphology. A comprehensive study of the internal and external structure of insects from the comparative viewpoint. 1 unit. Prerequisite: Biology 111 or equivalent; consent of instructor. Larsen, Sternburg.

413. Medical and Veterinary Entomology. Training in recognition, classification, methods of injury, habits, and control or destruction of insects, mites, and ticks which are predators, parasites, or disseminators of disease among men and domestic animals. 1 unit. Prerequisite: Entomology 103 or 302, or Zoology 320; consent of instructor. Horsfall.

420. Chemistry and Toxicology of Insecticides. Designed to provide the fundamental information available concerning the mode of action, the relationship of chemical structure to toxicity, and the physiological explanation of the chemical poisoning of insects. 1 unit. Prerequisite: One year of biology, or equivalent in animal science; organic chemistry; consent of instructor. Kearns, Metcalf, Sternburg.

422. Insect Physiology. A study of the principal physiological and biochemical functions of insects, exclusive of sensory functions. 1 unit. Prerequisite: Entomology 302, and 410; organic chemistry; consent of instructor. Friedman, Larsen.

423. Insect Behavior. An analysis of the physiological basis of insect behavior, including a thorough study of the various sensory systems. 1 unit. Prerequisite: Entomology 301 or equivalent; consent of instructor. Waldbauer.

424. Advanced Insect Physiology. A comprehensive study of the physiological and biochemical interactions between the insect and its environment including: sensory mechanisms, attractants and repellants, nutritional specialization, intermediary metabolism, energy production and utilization, metabolic activity accompanying functional changes, process controls. 1 unit. Prerequisite: Entomology 422; Chemistry 350; consent of instructor. Friedman, Larsen.

426. Seminar in Entomology. Discussions, reviews, and appraisals of special topics in the field of entomology. 0 or $\frac{1}{4}$ unit; may be repeated for a maximum of one unit. Prerequisite: Consent of instructor. Staff.

499. Thesis Research. Work may be taken in the following subjects: morphology and embryology of insects, applied entomology, systematic entomology, biology and

ecology of insects, insect toxicology, and insect physiology. 0 to 4 units. Fraenkel, Friedman, Ghent, Horsfall, Jaycox, Kearns, Larsen, Luckmann, MacLeod, Metcalf, Selander, Stannard, Sternburg, Waldbauer, Willis.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Introduction to Entomology. Devoted to integrated studies of the principal morphological and physiological characteristics of insects. 1 unit. Prerequisite: Biology 111; Chemistry 101; consent of instructor. Friedman, MacLeod, Sternburg.

302. Classification of Insects. Presents a comprehensive survey of the systematics and phylogeny of the orders and principal families of insects, together with practical experience in identification of these taxa. S; 1 unit. Prerequisite: Consent of instructor. Selander.

306. Special Problems. For students ready to take up some special investigation as the beginning of a thesis problem for an advanced degree. $\frac{1}{4}$ to 1 unit. Prerequisite: Consent of instructor. Staff.

312. Entomology for Teachers. Recognition of the chief orders of insects in their immature and adult stages, how they develop, life cycles, food, habitats, adaptations for feeding, oviposition, movement, protection, defense, making sound and other functions, interrelation with other organisms, environment, and social life. A collection of insects is identified, mounted, and labeled. Field trips, laboratory, and discussions. S; $\frac{1}{2}$ unit. Prerequisite: One year of biology, botany, zoology, or equivalent.

319. Fundamentals of Insect Control. Emphasis on the principles that underlie the control of important insect pests of agriculture and human and animal health. Study of integrated pest control involving biological, cultural, and chemical factors and of the ecology of the use of pesticides in the total environment. 1 unit. Prerequisite: Biology 111 and Chemistry 101, or equivalent; consent of instructor. Booth, Metcalf.

322. Insect Bionomics. This phase of the biology of insects deals with life history and conditions of environment that favor abundance of insects representative of various habitats. 1 unit. Prerequisite: Entomology 103, or 302, or Zoology 320; consent of instructor. Horsfall.

361. Individual and Group Behavior of Honey Bees. See Horticulture 361. $\frac{1}{2}$ unit. Prerequisite: One semester of entomology or zoology. Jaycox.

Microbiology

The Department of Microbiology offers graduate work leading to the Master of Science and Doctor of Philosophy. Students electing microbiology as a major for an advanced degree must have had, in addition to formal training in general bacteriology or microbiology, chemistry through quantitative analysis and organic chemistry, and fifteen hours of physical or biological sciences. Mathematics through calculus is strongly recommended.

Students who have fulfilled these requirements may apply for admission if they have a grade-point average of at least 4.0.

MOLECULAR BIOLOGY (Biophysical Chemistry)

The Department of Microbiology in collaboration with the Department of Chemistry and Chemical Engineering offers an area of specialization in biophysical chemistry. The program is flexible and provides the doctoral candidate with basic training in physical biochemistry and biology. Students electing this area should possess a solid background in physics and mathematics. Details of the curriculum are decided individually on the basis of the past experience and interests of the student. It is expected, however, that he will fulfill minor requirements in physical chemistry or biochemistry.

The major research areas are: (1) molecular basis of gene function; (2) structure and activities of proteins and nucleic acids; (3) intracellular organization and distribution of nucleoprotein components; (4) biosynthetic mechanisms of macromolecular replication; (5) immunochemistry.

FACULTY

Professors: L. L. Campbell (Head of Department), M. P. Bryant, R. D. DeMoss, J. W. Drake, R. E. Kallio, Z. J. Ordal, S. Spiegelman, C. R. Woese, R. S. Wolfe, M. J. Wolin.
Associate Professors: R. C. Meyer, P. S. Sypherd, J. T. Wachsman.
Assistant Professors: C. L. Hershberger, S. Kaplan, E. W. Voss.

COURSES FOR GRADUATES

402. Molecular Genetics. Same as Botany and Zoology 402. The nature of the gene, its mode of action, the mechanism of autosynthesis, the organization of the genetic material, and the regulation of gene action. ¾ unit. Prerequisite: Microbiology 330 or equivalent. Hershberger.

405. Microbiological Genetics. Same as Botany and Zoology 405. Breeding systems and recombinational analysis in microorganisms, with particular emphasis on protozoa and fungi. ¾ unit. Prerequisite: Microbiology 330; mathematics through calculus, or consent of instructor. Woese.

409. Cultivation and Properties of Microorganisms. Nutritional and metabolic properties of the major groups of microorganisms; a comparative study of the ecology, selective isolation, and cultivation of bacteria. Laboratory. 1 unit. Prerequisite: Chemistry 355 or equivalent; credit or registration in Microbiology 309; consent of instructor. Wolfe, Wolin.

412. Advances in Microbiology. Discussions of current research in several areas of microbiology. Discussions cover the following areas: (a) general microbiology, (b) microbial physiology and metabolism, (c) immunochemistry, (d) molecular genetics. ¼ unit. May be repeated for a maximum of one unit. Prerequisite: Consent of instructor. Staff.

419. Animal Virology. Same as Veterinary Medical Science 419. A discussion-laboratory with major emphasis on host-parasite relationships, natural history, and epidemiology supplemented with appropriate laboratory techniques as they pertain to the major groups of animal viruses. ¾ unit. Prerequisite: Microbiology 326 and 327 or Veterinary Medical Science 331 and 332; Chemistry 350 or 354; consent of instructor. Meyer.

420. Chemistry of Microbic Processes. The properties of microorganisms with emphasis on the metabolic pathways and chemical processes involved in the release of energy in the dissimulation of substrates by fermentation and respiration, and in the synthesis of cellular constituents. The metabolic types represented by microorganisms including the heterotrophic, autotrophic, and photosynthetic patterns are included. ¾ unit. Prerequisite: Microbiology 309 or 330 and Chemistry 234 and 350, or equivalent; consent of instructor. DeMoss.

451. Experimental Virology and Microbial Genetics. Experiments on the biology, replication, and genetics of bacteriophages and bacteria, with emphasis on experimental design by the students. 1 unit. Prerequisite: Microbiology 351; consent of instructor. Drake.

490. Individual Problems. ½ to 2 units. Prerequisite: Consent of instructor. Staff.

495. Seminar. Required of all graduate students whose major is microbiology. 0 or ¼ unit. Prerequisite: Ten hours of microbiology; consent of instructor. Staff.

499. Thesis Research. 0 to 4 units. Bryant, Campbell, DeMoss, Drake, Hershberger, Kallio, Kaplan, Meyer, Ordal, Spiegelman, Sypherd, Voss, Wachsman, Woese, Wolfe, Wolin.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

309. Comparative Microbial Chemistry. Emphasis is placed on comparative biochemical activity and other chemical characteristics as a basis for the discussion of the features of major groups of microorganisms. Comparison of the energy metabolism of the microbial groups is stressed. Lecture. 1/2 unit. Prerequisite: Chemistry 350 or equivalent. WOLFE, WOLIN.

311. Food and Industrial Microbiology. The relationship of microorganisms to food manufacture and preservation and to industrial fermentation and processing and to sanitation. Lecture. 3/4 unit. Prerequisite: Microbiology 101 or 201 or 309, or equivalent, and credit or registration in organic chemistry; or consent of instructor. ORDAL.

312. Techniques of Applied Microbiology. A consideration, through experimentation, of the properties of the bacteria, yeasts, molds, and actinomycetes which are important to industrial processes. The methods of control of microbial processes in industry and sanitation are explored. Laboratory. 1/2 unit. Prerequisite: Credit or registration in Microbiology 311. ORDAL.

326. Pathogenic Bacteriology. A study of the parasitism and pathogenic microorganisms: classification, morphology, cultural requirements and reactions, toxins, diagnostic tests, methods of differentiation and recognition, and the diseases bacteria cause. Lectures and laboratory. 1 unit. Prerequisite: Microbiology 101 or 201; organic chemistry. MEYER.

327. Immunochemistry. A survey of the field of immunology with emphasis on its chemical aspects. Lectures and laboratory. 1 unit. Prerequisite: Credit or registration in biochemistry or consent of instructor. VOSS.

330. Metabolic Regulation and Genetics of Microorganisms. Modern contributions to the science of microbiology, including considerations of the micro- and macromolecular anatomy of the bacterial cell, the physiological and genetic behavior of microorganisms, and the role of bacterial viruses as agents involved in the transfer of genetic information. Lecture. 3/4 unit. Prerequisite: Microbiology 101 or 201, or equivalent; credit or registration in biochemistry or consent of instructor; calculus strongly recommended. SYPHERD, WOESE.

331. Microbial Physiology and Anatomy. Discussions and problems concerning the growth, physiology, anatomy, and death of microorganisms. 3/4 unit. Prerequisite: Microbiology 200 or equivalent; Chemistry 350 or equivalent. DEMOS.

351. Viruses, I. Same as Botany and Zoology 351. The study of viruses emphasizing the bacteriophages; statistical, physical, biological, and chemical properties of viruses; analysis of host-virus interactions and of viral genetics. 3/4 unit. Prerequisite: Organic chemistry; biochemistry and calculus recommended. DRAKE.

352. Viruses, II. Same as Botany and Zoology 352. Extension of the principles developed in Microbiology, Botany, and Zoology 351 to the study of special plant, animal, and bacterial virus systems. 3/4 unit. Prerequisite: Botany, Microbiology, and Zoology 351, or consent of instructor; biochemistry and calculus recommended. BLACK, MACLEOD, REICHMANN.

Physiology and Biophysics

The Master of Science and Doctor of Philosophy are granted both in physiology and in biophysics.

PHYSIOLOGY

Applicants for graduate study in physiology are screened by an admissions committee and normally are admitted if their junior-senior grade-point average is 4.0 or better (scale of 5), and if their background training is adequate. Applicants with averages between 3.5 and 4.0

are considered, and may be admitted if their performance indicates adequate improvement, and if letters of recommendation indicate ability for graduate work. All transfer graduate students are judged on the basis of past performance. All new graduate students are interviewed by the physiology graduate student counselor. During the period when they are unassigned to a sponsor, new students are advised by the counselor concerning regulations and requirements of the department, the Graduate College, and the University; also concerning introductory courses in this and allied departments and any deficiencies in preparation.

Master of Science. Normally, students take a master's degree after completion of eight units of graduate study. During the master's program, students are expected to make up any undergraduate deficiencies. The program of study usually includes (a) Physiology 401, 402, 403, and 404; (b) two or three units from other departments (usually including biochemistry) and from the seminar and specialized courses in this department; and (c) one or two units of Physiology 491. For students whose undergraduate preparation has been deficient, additional courses may be recommended. Each student must submit a report based on original research; usually the research and report are part of the work done in Physiology 491. During the semester when the requirements for the master's degree are completed, the candidate takes an oral examination administered by the Physiology Qualifying Committee. This is a general examination and includes a discussion of the research report.

Doctor of Philosophy. The student must receive a grade of A or B in each of the 400-series (Physiology 401, 402, 403, 404) courses. If a student receives a grade of C in *one* of these courses, he must take the course over and receive a grade of B or better or, if approved by the Qualifying Committee, submit satisfactory evidence that he has achieved adequate mastery of the areas in which he performed poorly. If a student receives a grade of C in *two* of the 400-series courses, he is not qualified for the Ph.D. program. The qualifying examination includes evaluation and discussion of a formal research report written by the student, and may serve as the general oral examination for the M.S. degree. A student may receive the M.S. degree but be found unqualified for the Ph.D. program. Final decision on admission to the Ph.D. program is made by the department faculty and is based not only upon the findings of the examining committee, but on the total academic record, the opinion of the sponsor concerning research potential, and the nature of the student's objectives and motivation.

Every candidate for the Ph.D. in Physiology is required to obtain a firm background in the general areas of mammalian, comparative, and cellular physiology, as well as a high degree of expertise in his area of specialization. He is also expected to develop proficiency in other appropriate disciplines, such as biochemistry, physical chemistry, statistics, and the history and philosophy of science.

The preliminary examination is taken after completion of at least sixteen units of graduate course work, completion of all courses specified by the student's advisory committee, and after satisfying the foreign language requirement. A student is also expected to have completed sufficient research so that he can present a firm thesis proposal to the examining committee. The emphasis in the preliminary examination is on ability to synthesize and generalize, and to plan research; it is intended to be more a test of critical scholarly ability than of detailed factual knowledge. The examination covers, but is not necessarily limited to, the areas of mammalian, comparative, and cellular physiology, and the concepts of disciplines related to the candidate's area of specialization.

Minor. Graduate students in other departments should notify the physiology office and are assigned to a departmental minor adviser according to their interests. For a sole minor, two of the four units must be in 400-level courses other than 491. A sequence of courses within one area of physiology is desirable for a minor.

BIOPHYSICS

The objective of the program in biophysics is to give the student sufficient training in physics, chemistry, and biology to enable him to apply the conceptual, instrumental, and mathematical approaches of the physical scientist to the solution of biological problems. The curriculum is designed primarily for students entering with previous training in the physical sciences, but students with a background only in biology may be eligible.

Admission requirements are one year of college biology, one year of college physics, chemistry through organic chemistry, and mathematics through calculus. However, any deficiencies can be corrected while in training. Applicants must have a grade-point average of at least 4.0.

Master of Science. To obtain the Master of Science, the student must offer at least eight units in biophysics and related subjects. The required courses are Biophysics 401, 402, and two units of additional biophysics courses; a thesis or examination in a special field is also required.

For students whose major training has been in the physical sciences, the balance of courses should be selected from the biological science courses; students from the biological sciences select courses from the physical sciences.

Doctor of Philosophy. A flexible approach is made to curriculum requirements. Students are required, after approximately eight units of graduate study, to pass a qualifying examination, and after sixteen units, to pass the preliminary examination. An acceptable course program is given below:

(1) Mathematics, physics, and chemistry: Mathematics 343 or 345; Physics 321, 341, 342, and 381; Chemistry 342, 344, 383, and 385 (a one-year sequence including lectures and laboratory); and Biochemistry 350 and 355. Students who have had comparable training in advanced courses in physical chemistry, upon approval of the faculty, need not take some of the recommended physics courses. A knowledge of colloidal and macromolecular phenomena equivalent to one semester of work comparable to Chemistry 346 is necessary for work in molecular biophysics.

(2) Biology: Three units of graduate course work in one of the major areas of biology, determined by the research interests of the student. At least one course in genetics is recommended.

(3) Biophysics: Biophysics 401 or equivalent; Biophysics 402 and two additional courses in biophysics (other than research).

(4) Minor areas: Students entering from the biological sciences may declare a minor in physics or chemistry, or a minor in both, utilizing required courses in these fields, while students entering from the physical sciences may declare a sole minor in a selected field of biology. Other minors are possible but must meet the approval of the faculty.

Minor. Subject to the approval of the faculty, candidates for the Doctor of Philosophy in other fields may take a minor in biophysics.

FACULTY

Professors: W. W. Sleator (Head of Department), H. W. Ades, J. D. Anderson, W. R. Ashby, H. S. Ducoff, F. Dunn, C. Gianturco, J. Gorski, Govindjee, R. E. Johnson, J. R. Larsen, A. V. Nalbandov, C. L. Prosser, F. R. Steggerda, A. B. Taylor, H. I. Teigler, H. M. von Foerster.

Associate Professors: D. E. Buetow, E. Donchin, J. E. Heath, B. A. Hertig, S. G. Stolpe, C. Sybesma, A. R. Twardock, J. S. Willis.

Assistant Professors: D. W. Badger, J. A. Connor, G. L. Jendrasiak, E. S. Kirk, D. C. Sweeney.

Physiology

COURSES FOR GRADUATES

401. Physiology of Systems and Organs. Analysis of organization and function of vertebrate systems, combining the viewpoints of traditional cellular, comparative, mammalian, and human physiology; nervous, circulatory, digestive, and excretory systems; gross metabolism. 1 unit. Prerequisite: One year of college-level physics; chemistry through organic; an upper division course in physiology; physical chemistry and biochemistry recommended; knowledge of calculus presumed. Staff.

402. Comparative and Adaptational Physiology. Analysis of mechanisms of adaptation to the environment and to environmental stress, combining the viewpoints of traditional cellular, mammalian, and human physiology, with particular emphasis on the comparative approach. Homeostatic theory, nutrition, osmotic and ionic regulation, respiration and metabolism, temperature relations, sense organs, contractile systems. 1 unit. Prerequisite: One year of college-level physics; chemistry through organic; an upper division course in physiology; physical chemistry and biochemistry recommended; knowledge of calculus presumed. STAFF.

403. Cellular and Molecular Physiology. Physicochemical analysis of cellular function and consideration of the implications of the properties of cells for the physiology of multicellular animals. Cell and its organization, cell and the organism, protein structure and specificity, regulation of cell metabolism, cellular basis of hormone action, cell membranes, bioelectrics, muscle. 1 unit. Prerequisite: One year of college-level physics; chemistry including physical and biochemistry; an upper division course in physiology; knowledge of calculus presumed. STAFF.

404. Physiological Measurements. Lectures and laboratories concerned with an introduction at a graduate level to current research techniques in the physiological sciences. The laboratories are problem-oriented, and students select four to six special topics, at least one of which must be in each of the following major areas of physiology: (1) nervous system and muscles; (2) mammalian and human; (3) adaptation and radiation biology, and comparative physiology; (4) molecular, cellular, and endocrinological physiology. Within each area there are problems which fall into one or more of the following experimental categories: electrical-mechanical, chemical, and surgical. Selection of problems is done in conjunction with the course secretary so that the student obtains familiarity with techniques in each of these experimental categories and can devote some time to material of consequence relating to his own research interests. Emphasis is placed on the ability to work independently, and students give oral and written reports of their experimentation. $1\frac{1}{4}$ units. Prerequisite: Biochemistry 355 or equivalent, or consent of instructor. STAFF.

410. Mammalian Physiology Seminar. Current trends in mammalian physiology. $\frac{1}{2}$ unit. Prerequisite: Physiology 401 and 402, or equivalent; consent of instructor. KIRK, STEGGERDA.

412. Advanced Endocrinology. Same as Animal Science, Dairy Science, and Zoology 412. Seminar, lectures, student reports, and discussions of recent advances in endocrinology. $\frac{1}{2}$ unit; may be repeated for credit not to exceed a total of two units. Prerequisite: Physiology 312; consent of instructor. GORSKI, NALBANDOV.

413. Experimental Mammalian Physiology, I. The physiological applications of experimental mammalian surgery. 1 unit. Prerequisite: Physiology 401 and 402, or equivalent; consent of instructor. STEGGERDA.

414. Experimental Mammalian Physiology, II. The physiological applications of experimental pharmacodynamics. 1 unit. Prerequisite: Physiology 401 and 402, or equivalent; consent of instructor. STEGGERDA.

416. Structure and Function of the Nervous System. The understanding of nervous function through the experimental approach. 1 unit. Prerequisite: Two semesters of physiology courses beyond the elementary level; two semesters of general physics; consent of instructor. ADES.

421. Gross Human Anatomy. A general survey of the structures of the human body with emphasis on the relations between form and function. 1 unit. Prerequisite: One semester of embryology; consent of instructor. STOLPE.

431. Experimental Radiobiology. Laboratory exercises in irradiation procedures and in the examination of biological responses to ionizing radiations. 1 unit. Prerequisite: Physiology 331 or equivalent; consent of instructor. DUCOFF.

441. Advanced Comparative Physiology. Same as Zoology 441. Seminar, lectures, student reports, discussions. $\frac{1}{2}$ unit. Prerequisite: Consent of instructor. STAFF.

442. Advanced Comparative Physiology Laboratory. Same as Zoology 442. Laboratory experiments presenting comparative principles in osmotic and ionic regulation, respiration and metabolism, temperature regulation of animals, physiology of circulatory systems, of muscle, of sense organs and nervous systems. 1 unit. Prerequisite: Physiology 402, 403, and 404; credit or registration in Physiology 441. PROSSER.

451. Advanced Cellular Physiology. Same as Zoology 451. Seminar, lectures, student reports, discussions. ½ unit. Prerequisite: Consent of instructor. STAFF.

461. Fundamentals of Bioclimatology. Same as Geography 461. The effects of physical factors (such as barometric pressure, temperature, humidity, radiation, and air movement) on physiological processes in mammals; and the application of meteorological, climatological, and geographical techniques in physiological studies. ¾ unit. Prerequisite: Consent of instructor.

462. Experimental Bioclimatology. Same as Geography 462. Laboratory work and demonstrations on methods of measuring meteorological factors, of clinical thermometry, and partitional calorimetry; laboratory work on physiological adjustments of man to heat, cold, and high altitude. ½ unit. Prerequisite: Physiology 301, or 401 and 402; credit or registration in Physiology 461.

464. Advanced Human Bioclimatology. Same as Geography 464. Topics in human bioclimatology and medical geography, such as climatic determinism, meteorotropism, the weather elements as stresses, and acclimatization. ½ unit. Prerequisite: Physiology 461.

470. Human Pathologic Physiology. Disturbances of function in tissues and organs and their relationship to the pathogenesis of human disease. ¾ unit. Prerequisite: Two semesters of advanced physiology; one semester of biochemistry; consent of instructor. JOHNSON, TEIGLER.

472. Human Physiology Seminar. Topics of current emphasis in human physiology. ½ unit. Prerequisite: Two semesters of advanced physiology; one semester of biochemistry; consent of instructor. JOHNSON, TEIGLER.

473. Ergonomics Seminar. Same as Industrial Engineering 473. Topics in ergonomics are explored in depth, such as effects of vibration on human performance and biomechanics of the hand. ½ unit. Prerequisite: Industrial Engineering 306 or consent of instructor. HERTIG, JOHNSON.

491. Individual Topics. For graduate students who wish to study individual problems or topics not assigned in other courses. ½ to 2 units. Prerequisite: Approval of department. STAFF.

499. Thesis Research. 0 to 4 units. Research may be conducted in the following areas, with the consent of the instructor:

(a) **Cellular Physiology and Radiobiology.** ANDERSON, BUETOW, DUCOFF, GORSKI, PROSSER, SLEATOR, TAYLOR, WILLIS.

(b) **Comparative Physiology.** ANDERSON, HEATH, LARSEN, PROSSER, SWEENEY, WILLIS.

(c) **Mammalian Physiology.** ADES, BADGER, GIANTURCO, KIRK, NALBANDOV, STEGGERDA, TWARDOCK.

(d) **Human Anatomy and Human Physiology.** BADGER, JOHNSON, STOLPE.

(e) **Endocrinology.** FOSTER, GORSKI, NALBANDOV, STOLPE.

(f) **Neurophysiology.** ADES, DONCHIN.

(g) **Bioclimatology.**

(h) **Environmental and Stress Physiology.** HERTIG, JOHNSON.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. General Physiology. A consideration from the standpoint of experimental biology of functions that are common to most living organisms. ¾ unit. Prerequisite: Biology 111 or 251, or equivalent; one year each of college-level mathematics and physics; chemistry through organic. ANDERSON, STAFF.

302. Animal Physiology. Organ physiology of animals with emphasis on homeostasis and physiological interactions of animals with their environment. ¾ unit. Prerequisite: Biology 111 or 251, or equivalent; one year each of college-level mathematics and physics; chemistry through organic. ANDERSON, BADGER, STAFF.

303. General Physiology Laboratory. An introduction to experimentation with cellular functions that are common to most living organisms with emphasis on biochemical, radioactive tracer, electrical and mechanical recording techniques. ¼ unit. Prerequisite: Credit or registration in Physiology 301.

304. Experimental Physiology Laboratory. Introduction to problems and techniques for studying the physiology of organ systems. ¼ unit. Prerequisite: Credit or registration in Physiology 302.

305. Principles of Ergonomics. Same as Industrial Engineering 305. Concepts and design criteria to achieve optimum mutual adjustment of man and his work. Static and dynamic forces on the human frame; response to environmental stress (heat, vibration, noise); vigilance and fatigue; and man-machine systems are considered. 1 unit. Prerequisite: Consent of instructor. HERTIG, JOHNSON.

306. Quantitative Methods in Ergonomics. Same as Industrial Engineering 306. Laboratory problems and discussion on measurements of the physical and mental capacities and limitations of human beings in relationship to the stresses and demands of working environment. Students become familiar with techniques and tools such as assessment of human energy expenditures on an industrial job, use of seating research chair; high speed and time lapse photography. Student teams select about six problems from a list of topics, or they may develop problems of special interest to the team. 1 unit. Prerequisite: Physiology or Industrial Engineering 305. HERTIG, JOHNSON.

312. Endocrinology. Same as Zoology 312. The glands of internal secretion with special reference to the vertebrates. ¾ unit. Prerequisite: Physiology 301 or a course in biochemistry; consent of instructor. GORSKI.

313. Experimental Endocrinology. Same as Zoology 313. Laboratory techniques and project in endocrinology. ½ unit. Prerequisite: Credit or registration in Physiology or Zoology 312; consent of instructor. GORSKI.

331. General Radiobiology. Responses of multicellular organisms, cells, and macromolecules to ionizing radiations. Lectures, student reports, and discussions. 1 unit. Prerequisite: One year each of mathematics, physics, chemistry, and biology. DUCOFF.

369. Introduction to Human Ecology. Same as Anthropology, Geography, Health Education, Psychology, Sociology, Veterinary Medical Science, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations, and physiological, psychological, and sociological adjustments to environment, regulation of populations, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology; one year of anthropology, geography, geology, or sociology. TODD, STAFF.

374. Problems in Human Ecology. Same as Anthropology, Geography, Health Education, Psychology, Sociology, and Veterinary Medical Science 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multi-disciplinary studies of selected current problems. 1 unit. Prerequisite: Anthropology, Geography, Health Education, Physiology, Psychology, Sociology, or Zoology 369. LEVINE, STAFF.

Biophysics

COURSES FOR GRADUATES

401. Advanced Biophysics, I. Topics from electrobiology, muscle biophysics, and physical properties of biological media. 1 unit. Prerequisite: One year of physics beyond intro-

ductory physics or equivalent; calculus; physical chemistry; or consent of instructor. JENDRASIAK, STAFF.

402. Advanced Biophysics, II. Topics from photobiology and bioenergetics. 1 unit. Prerequisite: One year of physics beyond introductory physics or equivalent; calculus; physical chemistry. SYBESMA, STAFF.

403. Biophysical Techniques. This course is designed to acquaint the student with physical methods useful in the solution of biological problems. Topics covered are bioelectric measurements, including basic electronics; optical methods, including microscopy, spectrophotometry, and measurement of action spectra; use of high energy radiations; tracer techniques; acoustical techniques. ½ or 1 unit. Prerequisite: Consent of instructor. STAFF.

410. Special Topics in Biophysics. An advanced course on some topic of interest in biophysics, such as electrobiology, radiation biology, photobiology, bioacoustics, or the physics of muscular contraction. ½ to 1 unit. Prerequisite: Biophysics 401 and 402 or equivalent. STAFF.

411. Seminar. Survey of the literature in one area of biophysics, with special emphasis on student reports. ½ unit. Prerequisite: Enrollment in the biophysics program or consent of instructor. STAFF.

436. Problems of Cybernetics. Same as Communications 436 and Electrical Engineering 474. The study of brain-like processes in complex dynamic systems with emphasis on unsolved problems, current developments, and opportunities for research. 1 unit. Prerequisite: Consent of instructor. ASHBY.

463. Radioisotopes in Biological Research: Principles and Practice. See Veterinary Medical Science 463. ¾ unit. Prerequisite: Quantitative chemistry; one year each of mathematics, physics, biology, and/or consent of instructor.

491. Individual Topics. For graduate students who wish to study individual problems or topics not assigned in other courses. ½ to 2 units. Prerequisite: Consent of instructor. STAFF.

499. Thesis Research. Research may be conducted in one of the areas listed below, subject to approval of the staff member concerned and the department in which the research is to be done. 0 to 4 units.

(a) Bioacoustics. DUNN.
(b) Cellular Physiology. BUETOW, SLEATOR.
(c) Electrobiology. CONNOR, PROSSER.
(d) Physical Properties of Lipids and Membranes. JENDRASIAK.
(e) Photobiology. SYBESMA.
(f) Photosynthesis. GOVINDJEE, SYBESMA.
(g) Microbiology. WOESE.
(h) Physics of Muscular Contraction. PROSSER, SLEATOR.
(i) Radiobiology. DUCOFF.
(j) Information Theory and Cybernetics. ASHBY, VON FOERSTER.
(k) Ion Transport and Permeability. JENDRASIAK, WILLIS.
(l) Mechanical Properties of Tissues. DUNN.
(m) Vascular Dynamics. KIRK.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Introduction to Biophysics. A review of the field of biophysics designed to introduce the student to the types of biological problems currently under investigation in biophysical laboratories. ¾ unit. Prerequisite: Eight hours of physics or enrollment in the graduate biophysics program. SYBESMA.

312. Introduction to Radiobiology. Nature and mechanisms of the biological consequences of low dose and chronic irradiation. Intended primarily for students in engineering and physical sciences. ½ unit. Prerequisite: Mathematics 142 or 143; eight hours of physics; consent of instructor. DUCOFF.

Zoology

The Department of Zoology offers work leading to the degrees of Master of Science and Doctor of Philosophy. Several areas of specialization are available.

The grade-point average for admission is 4.0. Applicants with grade-point averages below 4.0 but above 3.75 are considered on an individual basis. Applicants should have completed twenty-five hours of biology, three semesters of college chemistry including organic, two semesters of college mathematics including analytic geometry, and two semesters of physics, or equivalent. Knowledge of a foreign language is necessary and the following are recommended: French, German, Russian.

The Master of Science requires eight units of graduate credit. Many of the courses listed under biology are taught by members of the Department of Zoology. Biology courses may be utilized toward meeting the requirements of degrees in zoology in the same manner as zoology courses. Students may be required to complete a thesis (Zoology 499), or a research report (Zoology 490), and, at the end of the program, complete a successful examination.

Admission to advanced standing requires the master's degree or the equivalent, a 4.0 grade-point average in non-thesis biology courses, and presupposes that the minimum science requirements specified for the master's degree have been met. One course in statistics is required. Quantitative chemistry, calculus, biochemistry, and other courses may be recommended by the adviser or doctoral committee. All inquiries concerning zoology graduate programs, assistantships, fellowships, and admission should be addressed to the department office, 287 Morrill Hall (not to the Graduate College or the Office of Admissions and Records).

Graduate students in other departments who choose zoology as a minor must have had at least one year of undergraduate work in zoology.

FACULTY

Professors: R. L. Metcalf (Head of Department), E. M. Banks, G. W. Bennett, L. L. Getz, B. V. Hall, J. Hirsch, D. F. Hoffmeister, L. Ingle, S. C. Kendeigh, R. L. Kirk (Visiting), J. B. Kitzmiller, F. J. Kruidenier, N. D. Levine, A. V. Nalbandov, D. L. Nanney, C. L. Prosser, G. C. Sanderson, P. H. Silverman, P. W. Smith, R. L. Watterson.

Associate Professors: R. Davenport, D. C. Eades, A. W. Ghent, J. E. Heath, M. R. Lee, M. R. Matteson, H. H. Shoemaker.

Assistant Professors: Nelda E. Alger, E. H. Brown, T. H. Frazzetta, G. H. Kieffer, H. V. Leland, M. Salmon, E. B. Small, D. L. Stocum, D. C. Sweeney, G. S. Whitt, Mary F. Willson.

COURSES FOR GRADUATES

402. Molecular Genetics. See Microbiology 402. $\frac{3}{4}$ unit. Prerequisite: Microbiology 330 or equivalent. Atwood, Woese.

405. Microbiological Genetics. See Microbiology 405. $\frac{3}{4}$ unit. Prerequisite: Microbiology 330; mathematics through calculus, or consent of instructor. Atwood, Nanney.

406. Physiology of Reproduction. Same as Animal Science 406. Comparative physiology of reproduction and endocrinology of domestic and laboratory animals; fertility and sterility. Lectures and laboratory. 1 unit. Nalbandov.

407. Evolutionary Theory. Genetic, systematic, ecological, and zoogeographical concepts as related to the process of evolution. 1 unit. Prerequisite: One course in genetics; consent of instructor.

408. Laboratory Methods in Physiology of Reproduction. Same as Animal Science 408. $\frac{1}{2}$ to 1 unit. Prerequisite: Consent of instructor. Nalbandov.

410. Theoretical Population Biology. A detailed examination of structure and process in population biology integrating population ecology and genetics and emphasizing theoretical concepts, quantitative relationships, and recent developments. 1 unit. Prerequi-

site: Calculus; credit or registration in Biology 311; consent of instructor. Statistics is highly recommended.

412. Advanced Endocrinology. See Physiology 412. Course may be repeated for credit not to exceed a total of two units. ½ unit. Prerequisite: Physiology 312; consent of instructor. GORSKI, NALBANDOV.

418. Advanced Protozoology. Advanced consideration of selected topics, with emphasis on laboratory practice in modern methods and techniques of studying both free-living and parasitic protozoa: collecting, culturing, and staining of representative forms. Offered in 1970-1971 and in alternate years. 1 unit. Prerequisite: Zoology 318 or equivalent. SMALL.

419. Topics in Experimental Protozoology. Consideration of the advantageous employment of protozoa in modern researches concerned with basic biological problems; selected experimental topics covered by lectures, demonstrations, discussions, reports, and readings. Offered in 1971-1972 and in alternate years. ½ or 1 unit. Prerequisite: Consent of instructor. SMALL.

420. Experimental Invertebrate Zoology. Study of current research problems and practice in the experimental methods used in the area of invertebrate zoology. 1 unit. Prerequisite: Zoology 320 or equivalent; consent of instructor. SWEENEY.

421. Cytogenetics. See Botany 421. 1 unit. Prerequisite: Biology 210, or Microbiology 330, or consent of instructor. STEFFENSEN.

422. Advanced Parasitology. Advanced study of modern methods in helminthology. 1 unit. Prerequisite: Zoology 321 or equivalent. KRUIDENIER.

424. Invertebrate Taxonomy. Individual problems in taxonomy of invertebrates. Offered in 1971-1972 and in alternate years. 1 unit. Prerequisite: Zoology 304. MATTESON.

425. Experimental Parasitology. Same as Veterinary Medical Science 425. A broadly based consideration of the relation of parasites to their hosts and to their environments, and of the factors which influence these relationships. 1 unit. Prerequisite: A laboratory course in parasitology or protozoology; organic chemistry; Chemistry 350; biochemistry and statistics are recommended. LEVINE, SILVERMAN.

433. Topics in Developmental Biology. A study of initial differences in developing systems and interactions leading to more complex differences. May be elected in successive years. ¼ unit. Maximum credit for master's candidates, one unit; for doctoral candidates, three units. Prerequisite: Zoology 367. WATTERSON.

441. Advanced Comparative Physiology. See Physiology 441. ½ unit. Prerequisite: Consent of instructor. STAFF.

442. Advanced Comparative Physiology Laboratory. See Physiology 442. 1 unit. Prerequisite: Physiology 402, 403, and 404; credit or registration in Physiology 441.

444. Concepts of Ethology. Group discussion of problems such as stimulus filtering, spontaneity, and stereotyped motor patterns, with a new topic each semester. ½ unit. Prerequisite: Zoology 346. BANKS.

445. Seminar in Fish and Wildlife Ecology. Modern ecological principles and concepts to specific problems in fisheries and wildlife. Offered in 1971-1972 and in alternate years. ½ unit. Prerequisite: Zoology 342 or 345, or equivalent.

446. Physiological Ecology. Physiological adjustments and responses of organisms to their environment. 1 unit. KENDEIGH.

447. Advanced Ecology. Designed to provide experience with the current technology of animal behavior study, including sound spectrographic analysis, cinematographic time and motion study, and other procedures. 1 unit. Prerequisite: Consent of instructor. BANKS, SALMON.

451. Advanced Cellular Physiology. See Physiology 451. ½ unit. Prerequisite: Consent of instructor. STAFF.

467. Experimental Embryology. 1 unit. Prerequisite: Zoology 367. WATTERSON.

490. Individual Research. For master's degree candidates who elect to write a research report rather than a thesis. No more than three units may be included in the master's degree program. ½ to 3 units. Prerequisite: Consent of adviser. STAFF.

491. Topics in Population Biology. A seminar course devoted to discussion of problems in population biology, with a different topic each semester. ½ unit. Total credit is limited to four units. Prerequisite: Consent of instructor.

499. Thesis Research. 0 to 4 units. Work in the following fields is offered for students registered in Zoology 499:

Anatomy, Physiology, and General Classification of Vertebrates: Endocrinology, HALL, NALBANDOV; Functional Anatomy, FRAZZETTA; Histology, DAVENPORT; Ultrastructure, HALL; Vertebrate Physiology, HEATH, PROSSER.

Anatomy, Physiology, and General Classification of Invertebrates: Helminthology. KRUIDENIER, LEVINE, SILVERMAN; Invertebrate Zoology, MATTESON, SWEENEY; Invertebrate Physiology, PROSSER, SWEENEY; Parasitology, ALGER, KRUIDENIER, SILVERMAN; Protozoology, SMALL.

Embryology and Basic Knowledge of Cells and Tissues: Cytology, DAVENPORT; Embryology and Regeneration, DAVENPORT, WATTERSON; Toxicology, INGLE, METCALF.

Principles of Ecology, Principles of Taxonomy, Natural History: Ecology, GETZ, GHENT, KENDEIGH, WILLSON; Ethology, BANKS, HIRSCH, SALMON; Ichthyology, SHOEMAKER, P. SMITH; Limnology, BENNETT, MATTESON; Mammalogy, HOFFMEISTER, LEE; Ornithology, KENDEIGH, WILLSON; Taxonomy, EADES; Wildlife Management, KENDEIGH, SANDERSON, SHOEMAKER.

Genetics and Evolution: Genetics and Evolution, BROWN, KITZMILLER, NANNEY; Vertebrate Phylogeny and Paleontology, FRAZZETTA.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. General Seminar. For members of the staff and graduate students. Required of all graduate students, but also open to seniors whose major is zoology. No credit. Attention is called to the following special clubs and seminars, some of which are interdepartmental: Animal Ecology Club, Genetics Seminar, Endocrinology Seminar, and Parasitology-Protozoology Seminar.

303. Individual Topics. For those who wish to study individual problems. Graduate students may register for topics involving individual work not assigned in other courses. Laboratory, conferences, and readings. ½ or 1 unit. Prerequisite: Two years of zoology or consent of department. STAFF.

304. Field and Systematic Zoology. Collection, preservation, and identification of lower vertebrates and land and fresh-water invertebrates; habits and life histories of selected forms. 1 unit. Prerequisite: Biology 110 or 111 or Biology 151 and 251, or equivalent; consent of instructor. MATTESON.

312. Endocrinology. See Physiology 312. ¾ unit. Prerequisite: Physiology 301 or a course in biochemistry; consent of instructor. GORSKI.

313. Experimental Endocrinology. See Physiology 313. ½ unit. Prerequisite: Credit or registration in Physiology or Zoology 312; consent of instructor. GORSKI.

318. Protozoology. Basic treatment of the morphology, physiology, and systematics of the protozoa; also consideration of their evolution, ecology, morphogenesis, sexual phenomena, genetics, and parasitism, with life histories of selected free-living and parasitic forms. 1 unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent. SMALL.

320. Invertebrate Zoology. Invertebrates; structure and development. Application of biological principles. Specific and comparative morphology of the invertebrates; coordination of structure and function, origin, development, and life histories. 1 unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent. SWEENEY.

321. Parasitology. Parasites, life cycles, morphology, taxonomy, environmental relations. Lecture, laboratory, technique, readings, quiz demonstrations, and problems. 1 unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent. KRUIDENIER.

324. Vertebrate Paleontology. Same as Geology 324. Phylogeny, morphology, and ecology of the fossil vertebrates. Lecture, laboratory, and field trips. Offered in 1970-1971 and in alternate years. ½ unit. Prerequisite: Zoology 232 or Geology 102.

330. Practical Microtechnique. An introduction to microscopy, microphotography, and histological technique. ½ unit. Prerequisite: Histology or embryology and consent of instructor. ALGER, KRUIDENIER.

331. Experimental Cytology. See Botany 331. 1 unit. Prerequisite: Biology 151, 210, or 251; consent of instructor. DAVENPORT, STEFFENSEN.

332. Advanced Vertebrate Zoology. Vertebrate morphology; comparative anatomy, evolution, and function of vertebrate organ systems, with special emphasis on the evolution, anatomy, and function of the skeletal and nervous systems. Lectures and laboratory. 1 unit. Prerequisite: Zoology 232. FRAZZETTA.

333. Vertebrate Embryology. The development of the vertebrate body and its organs. 1 unit. Prerequisite: Biology 111 or 251, or equivalent. WATTERSON.

335. Ornithology. Structure, functions, environmental relations, habits, life history, and identification of birds. Laboratory during the first eight weeks and field trips during the last eight weeks of the semester. ½ unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent. KENDEIGH, WILLSON.

336. Mammalogy. Classification, distribution, life history, evolution, and identification of mammals. Lecture, laboratory, and field work. 1 unit. Prerequisite: Zoology 232. HOFFMEISTER, LEE.

337. Ichthyology. Classification, structure, evolution, distribution, and life history of fish. Lectures. laboratory, and field work. ½ unit. Prerequisite: Zoology 232. SHOEMAKER.

338. Herpetology. Classification, distribution, life history, and identification of reptiles and amphibians, particularly those of the United States. Lectures, laboratory, and field work. Offered in 1970-1971 and in alternate years. ½ unit. Prerequisite: Zoology 232.

340. Natural History of the Vertebrates. Identification, distribution, adaptation, food, ecology, and life history with emphasis on vertebrates of Illinois. Lectures, laboratory, and field work. 1 unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent; consent of instructor. WILLSON.

341. Field Ecology. During spring vacation, study of biotic communities, mammals, birds, reptiles, amphibia, fishes, and invertebrates in various sections of North America. Outdoor camping and cooking. Transportation in University cars. ¼ unit. Prerequisite: Credit or registration in one of the following: Zoology 304, 335, 336, 337, 338, 340, 345; consent of instructor. GETZ, KENDEIGH, SHOEMAKER.

342. Wildlife Management and Conservation. Size and measurement of animal populations, factors affecting reproduction and mortality, life history, management policies for fish, mammals, and birds. ½ unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent. SHOEMAKER.

343. Limnology. Fresh-water biology. Study of the lake, pond, and river with emphasis on the physical environment as well as on the plants and animals which live in fresh water. Lectures, discussions, laboratory, and field work. 1 unit. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent; consent of instructor. MATTESON.

345. Animal Ecology. Composition, dynamic development, and distribution of biotic communities. ¾ or 1 unit. Students enrolling for three-fourths unit are required to do field work on six Saturdays (recommended for those also enrolled in Zoology 342); those enrolling for one unit are required to do field or laboratory work every Saturday, including one weekend camping trip. Prerequisite: Biology 110 and 111, or 151 and 251, or equivalent. GETZ.

346. Ethology. Same as Animal Science 346. The behavior of animals as interpreted through comparative studies and experimentation. Lecture, $\frac{1}{2}$ unit; lecture and laboratory, 1 unit. Prerequisite: One year of 300-level courses in zoology, physiology, or psychology; consent of instructor for laboratory enrollment.

361. Individual and Group Behavior of Honey Bees. Same as Horticulture 361. $\frac{1}{2}$ unit. Prerequisite: One semester of entomology or zoology. JAYCOX.

367. Analysis of Development. Advanced study of basic problems in developmental biology. Major emphasis is placed on interactions at molecular, fine structural, and cellular levels, and the genetic and metabolic mechanisms by which these interactions are controlled in plants and animals. Theories of differentiation are critically examined in the light or recent research. Lectures, discussions, outside readings, and student reports. $\frac{3}{4}$ unit. Prerequisite: Biology 211 or Zoology 333; Biology 210; organic chemistry.

369. Introduction to Human Ecology. Same as Anthropology, Geography, Health Education, Physiology, Psychology, Sociology, and Veterinary Medical Science 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations, and physiological, psychological, and sociological adjustments to environment, regulation of populations, and control of the environmental regulating factors. $\frac{1}{2}$ or 1 unit. Prerequisite: One year of biology; one year of anthropology, geography, geology, or sociology. KENDEIGH, SHIMKIN, STAFF.

LINGUISTICS

(Including Arabic, Modern Hebrew, Hindi, Modern Greek, Swahili, and Yoruba)

The Department of Linguistics offers a graduate program leading to the Master of Arts and Doctor of Philosophy. The following fields of linguistics are available for concentration: descriptive linguistics, historical linguistics, applied linguistics, interdisciplinary study in psycholinguistics, ethnolinguistics, experimental phonetics, and mathematical linguistics.

Undergraduate preparation for the study of linguistics should include the equivalent of at least three years of foreign language experience; for historical linguistics, a broad background in the humanities and social studies; and for descriptive linguistics, the equivalent of good undergraduate training in mathematics and the sciences. Students applying for admission should have at least a 4.0 grade-point average for that portion of the work which represents the last sixty hours earned toward the bachelor's degree. Applications of students with a grade-point average between 3.5 and 3.99 are considered on an individual basis.

Master of Arts. The aim of the master's program is to introduce students to the important areas of linguistics and the methods of linguistic analysis. Candidates for this degree must earn eight units, of which six units must be in linguistics and must include Linguistics 300, 301, 302, 340, 401, and 402.

In addition to fulfilling the general requirements of the Graduate College, the student must pass the reading examination in one foreign language (French, German, or Russian), pass the comprehensive qualifying examination in general linguistics (and special subjects, if appropriate), and must submit a satisfactory master's essay to the department; admission to the qualifying examination is contingent upon success in the language examination.

Doctor of Philosophy. Admission to candidacy for this degree normally requires a grade-point average of 4.5 or better for all graduate work in linguistics. Candidates for this degree must complete at least twenty-four units of graduate work, or sixteen units beyond the master's degree. The minimum twenty-four units must include the course requirements listed above for the master's degree (or their equivalent), Linguistics 404, 481, 482, courses in the structure of non-Western languages, and eight units of Linguistics 499.

Students are encouraged to attend at least one summer session of the Linguistic Institute of the Linguistic Society of America. Up to four units of credit granted by the host university under this program may be transferred. Students of descriptive linguistics also are urged to

establish a vested interest and a firm basic foundation in some particular language family at as early a point as possible in their graduate career.

Candidates must demonstrate proficiency in two languages other than English (French, German, or Russian) and must pass the comprehensive qualifying examination (mentioned above for the master's degree), preferably after the first year of graduate work. With consent of department, a special arrangement can be made for second language requirement.

Linguistically oriented courses in related departments may be counted toward the major if approved by the adviser. The head of the department acts as general adviser to each student until he selects his field of concentration, at which time he comes under the guidance of an adviser in his special area.

FACULTY

Professors: B. B. Kachru (Head of Department), J. H. D. Allen, Katharine O. Aston, J. B. Cassagrande, C. L. Dawson, H. R. Kahane, R. B. Lees (on leave), F. K. Lehman, J. W. Marchand, M. A. Morinigo, C. Osgood.

Associate Professors: E. H. Antonsen, R. Dunatov, F. S. Gladney, F. M. Jenkins, Yamuna Kachru, C-W. Kim, H. Maclay, I. Rauch, W. R. Zemlin.

Assistant Professors: D. A. Abdo, L. F. Bouton, M. L. Geis, C. W. Kisseberth, S. Makino, D. G. Miller, D. Wanner, J. F. Yegerlehner.

Linguistics

COURSES FOR GRADUATES

401. Syntax. Critique of traditional and contemporary theories of syntactic structure; systematic introduction to transformational grammar. 1 unit. Prerequisite: Linguistics 300 or equivalent. Geis.

402. Phonology. Examination of language-specific phonological problems with a view toward formulating a language-independent theory of phonology. 1 unit. Prerequisite: Linguistics 301 or consent of instructor. Kisseberth.

403. Seminar in Linguistic Analysis. Discussion of advanced topics of current interest in descriptive linguistics. 1 unit. May be repeated for credit with consent of instructor. Prerequisite: Linguistics 401. Staff.

404. Practicum. Classroom- and homework-solving of assorted problems in syntactic and phonological analysis of many languages. 1 unit. Prerequisite: Linguistics 401 and 402.

405. Seminar in Stylistics. A seminar designed to evaluate and discuss earlier and current linguistically motivated stylistic theories; emphasis on the theoretical and methodological problems in application of linguistics to stylistic analysis of literary texts. 1 unit. Prerequisite: Linguistics 300 or 305; consent of instructor. B. Kachru.

407. Advanced Topics in Mathematical Linguistics. The hierarchy of automata and the hierarchy of grammars; equivalence theorems and undecidability theorems; recognition procedures. 1 unit. Prerequisite: Linguistics 307 or equivalent. Staff.

408. Russian Phonology. Same as Russian 408. Synchronic examination of the phonological system of modern Russian and of its interrelation with the syntactic and lexical systems; brief discussion of the historical development of the phonological system. 1 unit. Prerequisite: Consent of instructor.

409. Field Methods in Linguistics. Same as Anthropology 409. The recording and analysis of a spoken language with a native speaker of that language as an informant. 1 unit. Prerequisite: Credit or registration in Linguistics 401. Lehman, Stahlke.

410. Advanced Field Methods in Linguistics. Same as Anthropology 410. Advanced analysis of a spoken language with a native speaker of that language as an informant. 1 unit. Prerequisite: Linguistics or Anthropology 409, or equivalent. Lehman, Stahlke.

411. Methods in Historical Linguistics. Advanced analysis of genetic comparison and reconstruction, linguistic borrowing, linguistic geography, etymology, and related topics. 1 unit. Prerequisite: Linguistics 302 or 315. Hock, Kahane, Miller.

412. Research Seminar in Historical Linguistics. Research work in etymology, linguistic geography, and historical syntax. 1 unit. Prerequisite: Linguistics 411 or consent of instructor. Kahane, Miller.

415. Seminar in Indo-European Linguistics. Discussion and research paper on topics in Indo-European languages, their history, origins, development, and migration. 1 unit. Hock, Miller.

419. Contrastive Linguistics. Same as Rhetoric 419. A critical survey of contemporary linguistic models with special reference to their relevance in preparing contrastive analyses of languages; detailed discussion on contrastive analyses of English and selected non-Western languages at different linguistic levels. ½ or 1 unit. Prerequisite: Linguistics 300 or consent of instructor. Y. Kachru.

420. Linguistic Phonetics. Principles of scientific description of the phonic aspect of language; distinctive features and phonetic alphabets; relations between phonetics and other linguistic levels; and inventory of speech sounds. 1 unit. Prerequisite: Linguistics 301 or equivalent. Kim.

421. Seminar in Phonetic Theories. Theories of speech production; motor theory and linguistic change; acoustical correlates of vocal-tract configurations; theories of speech perception; and a model of universal phonetics. 1 unit. Prerequisite: Linguistics 301 or equivalent. Kim.

424. Linguistics and Communication. Same as Communications 424. The communicative function of language with emphasis on the application of linguistic theories and methods to problems in human communication. 1 unit. Maclay.

425. Psycholinguistics. Same as Communications and Psychology 425. A critical survey of methods and theories in the psychological study of the communication process with emphasis upon linguistic, information-theory and learning-theory approaches, psycholinguistic analysis of language decoding and encoding, and the development and measurement of symbolic processes, including meaning. 1 unit. Prerequisite: Consent of instructor. Osgood.

426. Research Seminar in Psycholinguistics. Same as Communications and Psychology 426. Critical discussion of research problems to which psycholinguistic theories and techniques can be applied. Students taking this course are expected to plan, execute, and report an original piece of research in this area during the course. ½ or 1 unit. Prerequisite: Linguistics 425; consent of instructor. Maclay, Osgood.

429. Second Language Acquisition and Bilingualism. Same as Psychology 429. An examination of the field from a psycholinguistic perspective. The following topics are discussed: first vs. second language acquisition, the nature of language aptitude and competence, methods of second language teaching, the nature of bilingualism, and comparative psycholinguistics. 1 unit. Prerequisite: Consent of instructor. Jakobovits.

450. Linguistics and the Study of Meaning. A consideration of those aspects of meaning which are the concern of linguistic theory. 1 unit. Prerequisite: Linguistics 300. Yegerlehner.

462. Introduction to Romance Linguistics. Same as French, Spanish, Italian, and Portuguese 462. Comparative and historical analysis of the Romance languages. ½ unit. Prerequisite: Four semesters of a Romance language or Latin, or equivalent. Kahane, Wanner.

473. Seminar in Phonetics. Same as Speech 473. Advanced study in phonetic theory and noninstrumental phonetic investigation. 1 unit. Prerequisite: Consent of instructor. Zemlin.

475. Experimental Phonetics, I. Same as Speech 475. Theoretical consideration of speech

as motor behavior, with special reference to physiological investigations of normal respiration, phonation, and articulation. Survey of the experimental literature. 1 unit. Prerequisite: Consent of instructor. ZEMLIN.

476. Experimental Phonetics, II. Same as Speech 476. Theoretical consideration of speech as an acoustical phenomenon, with special reference to acoustical investigations of voice and speech sounds. Survey of the experimental literature. 1 unit. Prerequisite: Consent of instructor. ZEMLIN.

477. Measurement of Speech, I. Same as Speech 477. Principles and methods of measuring speech action. Special action recorders and transducers; techniques of analysis; problems of experimental design. Laboratory experimentation. 1 unit. Prerequisite: Consent of instructor; credit or registration in Linguistics 475. ZEMLIN.

478. Measurement of Speech, II. Same as Speech 478. Principles and methods of measuring the acoustical phenomena of speech. Oscillographic measurement of vocal variables; special instruments and media for automatic graphic recording; analysis of data; problems of experimental design. Laboratory experimentation. 1 unit. Prerequisite: Consent of instructor; credit or registration in Linguistics 476. ZEMLIN.

481. Topics in Syntactic Theory. Investigation of syntactic universals; recent developments in the theory of syntax. 1 unit. Prerequisite: Linguistics 317, 387, or 401; consent of instructor. GEIS, MORGAN.

482. Topics in Phonological Theory. Continuation of Linguistics 402. Special topics and individual papers are assigned. 1 unit. Prerequisite: Linguistics 402 or equivalent. KISSEBERTH.

490. Special Topics in Linguistics. Individual studies in the areas of linguistics not covered by regular course offerings. ½ to 2 units. STAFF.

499. Thesis Research. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Introduction to Linguistics. Same as Anthropology 300. An introduction to the science of descriptive linguistics. ½ unit. Prerequisite: Fulfillment of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. STAFF.

301. Introduction to General Phonetics. An introduction to the main branches of general phonetics and phonological theory; emphasis on analysis of non-Western languages and research techniques. ½ unit. KIM.

302. Comparative Linguistics. An introduction to the historical aspects of language. ½ unit. Prerequisite: Fulfillment of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. KAHANE, WANNER.

303. Non-Western Linguistic Structures. Intensive study of linguistic structure of a selected non-Western language. May be repeated for credit with consent of instructor. 1 unit. STAFF.

305. Introduction to Applied Linguistics. An introduction to the applications of general linguistic theory to the specific fields of stylistics, theory of translation, contrastive analyses, and the teaching and learning of foreign (and second) languages. Practical assignment work. ¾ unit. Prerequisite: Consent of instructor. BOUTON, B. KACHRU.

307. Introduction to Mathematical Linguistics. Same as Anthropology 307. Principles of set theory, logic and formal systems, group theory, and automata theory; introduction to the formal theory of grammars. 1 unit. Prerequisite: Linguistics 300. STAFF.

308. Comparative Grammar of Greek and Latin. See Greek 308. ½ unit. Prerequisite: Latin 202 or equivalent; credit or registration in Greek 202.

315. Introduction to Indo-European Linguistics. Introductory survey of Indo-European languages and their mutual relations; exemplification of methods of reconstruction

through examples from Indo-European languages; discussion of theories about the original home, culture, and society of the Indo-Europeans; introductory presentation of the sound laws of the major Indo-European languages and of the overall structure of Indo-European morphology. 1 unit. Prerequisite: Fulfillment of the language requirement of the College of Liberal Arts and Sciences. HOCK, MILLER.

316. Structure of the French Language. Same as French 316. A general survey of the linguistic structure of modern standard French, including phonology, morphology, and syntax. Emphasis is on the differences between its spoken and written forms. ¾ unit. Prerequisite: French 313 or equivalent training in phonetics. JENKINS.

317. Languages of the World. Same as Anthropology 317. A survey of the main language families of the world from both genetic and typological points of view, with special reference to the theory of syntactic descriptions. ½ or 1 unit. Prerequisite: Linguistics 300 or consent of instructor. YEGERLEHNER.

320. Introduction to African Linguistics. Introduction to genetic and typological classification of the main language families of Africa; concentration on grammatical and phonological characteristics. 1 unit. Prerequisite: Linguistics 200 or 300; consent of instructor. STAHLKE.

325. Introduction to Psycholinguistics. Same as Communications 325. An introductory survey of psychological and linguistic approaches to the study of communication. 1 unit. Prerequisite: An introductory course in linguistics or psychology; consent of instructor. MACLAY.

330. Introduction to Far Eastern Linguistics. Same as Chinese, Japanese, and Korean 330. Introduction to genetic relation of the Far Eastern languages with other languages. Concentration on synchronic analysis of phonology and syntax. 1 unit. Prerequisite: Linguistics 300; consent of instructor. KIM, MAKINO.

338. Philosophies of Language. Same as Philosophy 338. A study of the development of philosophical problems about language and the treatment of them from antiquity through the nineteenth century. ¾ or 1 unit. Prerequisite: One course in philosophy. FABER.

340. History of Linguistics. Survey of linguistic theories from ancient to modern times; special emphasis on comparative grammar and the development of structural linguistics; extended discussion of at least one other period. 1 unit. Prerequisite: Linguistics 300 or equivalent. B. KACHRU, WANNER.

350. Sociolinguistics. A critical study of the sociologically oriented general linguistic theories with special reference to language varieties, language attitudes, language diversity, language standardization, linguistics geography, language and political roles (language loyalty). Emphasis on research methodology and techniques. Concentration on South Asia. ½ or 1 unit. Prerequisite: Linguistics 300 or consent of instructor. B. KACHRU.

351. Area Linguistics. Introduction to area classification, linguistic convergence, and borrowing; the Southeast Asia *Sprachbund;* phonological, morphological, and syntactic convergence. 1 unit. Prerequisite: Linguistics 300. LEHMAN.

360. Introduction to South Asian Linguistics. Introduction to genetic and typological classification of the main language families of South Asia; concentration on phonology and syntax. 1 unit. Prerequisite: Consent of instructor. Y. KACHRU.

367. Introduction to Germanic Linguistics. Same as Germanic 367. A comparative and historical survey of the Germanic languages. ½ unit. Prerequisite: Completion of the foreign language requirement in the College of Liberal Arts and Sciences, or equivalent. Some knowledge of German desirable.

370. Language, Culture, and Society. Same as Anthropology and Communications 370. An examination of the social and cultural functions of language, with particular emphasis on the application of linguistic methods and findings to selected problems in the social sciences. ½ or 1 unit. CASAGRANDE.

375. Speech Science, I. Same as Speech 375. Introduction to the anatomical and physiological characteristics of the normal speech and hearing mechanisms, and to the fundamental acoustics of speech. ½ unit. Prerequisite: Speech 109 or 301 or consent of instructor. ZEMLIN.

376. Speech Science, II. Same as Speech 376. Consideration of the physiology of the speaking act, the acoustical characteristics of voice and speech sounds, and the hearing of speech. ½ unit. Prerequisite: Speech 375 or consent of instructor. ZEMLIN.

380. Introduction to Slavic Linguistics. Same as Slavic 380. Changes in phonology and morphology from Indo-European to Common Slavic; geographical distribution of Slavic languages and dialects, prehistory and early history of the Slavs, and Balto-Slavic linguistic relationships. ¾ unit. Prerequisite: Reading knowledge of at least one Slavic language. DAWSON.

382. Introduction to Sanskrit Linguistics, I. The sounds and alphabet of Sanskrit; introduction to grammar, with drill and readings; sandhi rules; reading: Nala and Damayanti. 1 unit. Prerequisite: Linguistics 300; consent of instructor. HOCK.

383. Introduction to Sanskrit Linguistics, II. Further grammar and reading; consideration of Sanskrit from one or more of the following points of view: (1) comparative Indo-European linguistics, (2) Indology, (3) Paninian linguistics, (4) Western linguistic theories, (5) transformational-generative grammar. 1 unit. Prerequisite: Linguistics 382. HOCK.

387. The Structure of English. Same as English 387. Critical evaluation of traditional and structuralist grammatical descriptions; introduction to transformational grammatical studies; detailed survey of a transformational syntax of English; brief introduction to generative phonology and morphophonemic analysis of English, especially stress. ¾ unit. GEIS.

388. Linguistics in Language Learning, I. Same as Rhetoric 388. The application of linguistic methods in the learning of a second language, with special emphasis on the learning of English. ¾ unit. Prerequisite: Two years of a foreign language, or equivalent; consent of instructor. ASTON.

389. Linguistics in Language Learning, II. Same as Rhetoric 389. Applied linguistics in teaching and learning English as a second language, with special emphasis on the application of some principles of psycholinguistics, sociolinguistics, and ethnolinguistics along with the related disciplines of education, psychology, and anthropology to structured teaching/learning situations. ¾ unit. Prerequisite: Linguistics 388. ASTON.

Arabic

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. Intermediate Arabic, I. First term of second year of work in the Arabic language, with drill for more advanced conversational fluency; introduction to a greater variety of styles and levels of discourse and usage, increasing study of the written language, and more formal grammar. 1 unit. Prerequisite: Arabic 202 or equivalent. ABDO.

304. Intermediate Arabic, II. Concentration upon ability to enage in reasonably fluent discourse in Arabic, on comprehensive knowledge of formal grammar, and on ability to read ordinary written Arabic. 1 unit. Prerequisite: Arabic 303 or equivalent. ABDO.

305. Advanced Arabic, I. Reading selections from literary works; selections from political, social, historical, and economic writings. 1 unit. Prerequisite: Arabic 304 or equivalent. ABDO.

306. Advanced Arabic, II. A continuation of Arabic 305. Further reading in literary sources as well as in history, economics, and politics. 1 unit. Prerequisite: Arabic 305 or equivalent. ABDO.

307. Introduction to Arabic Literature, I. Select readings in Arabic literature with em-

phasis on the novel and short story. The course includes lectures and discussions on the theory of literature and Arabic aesthetics. 1 unit. Prerequisite: Arabic 304. ABDO.

308. Introduction to Arabic Literature, II. Select readings in Arabic literature with emphasis on poetry and plays. The course includes lectures and discussions on the theory of literature and Arabic aesthetics. 1 unit. Prerequisite: Arabic 304. ABDO.

Modern Hebrew

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. Intermediate Modern Hebrew, I. First term of the second year of the Hebrew language including drill for more advanced conversational fluency; increased study of the written language and more formal grammar. All students in this course are required to register for one hour per week in the language laboratory. 1 unit. Prerequisite: Modern Hebrew 202 or equivalent. STAFF.

304. Intermediate Modern Hebrew, II. Concentration on ability to engage in reasonably fluent discourse in Hebrew; comprehensive knowledge of formal grammar and an ability to read ordinary written Hebrew. All students in this course are required to register for one hour per week in the language laboratory. 1 unit. Prerequisite: Modern Hebrew 303 or equivalent. STAFF.

305. Advanced Modern Hebrew, I. A course for advanced knowledge of spoken and written standard Modern Hebrew. 1 unit. Prerequisite: Modern Hebrew 304 or equivalent.

306. Advanced Modern Hebrew, II. A course for advanced knowledge of spoken and written standard Modern Hebrew with emphasis on Modern Hebrew literature and language. 1 unit. Prerequisite: Modern Hebrew 305 or equivalent.

Hindi

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. Intermediate Hindi, I. First term of second year of work in the Hindi language, with drill for more advanced conversational fluency; introduction of a greater variety of styles and levels of discourse and usage, increasing study of the written language, and more formal grammar. 1 unit. Prerequisite: Hindi 202 or equivalent. SUBBARAO.

304. Intermediate Hindi, II. Concentration upon ability to engage in reasonably fluent discourse in Hindi, on comprehensive knowledge of formal grammar, and on ability to read ordinary texts in Hindi. 1 unit. Prerequisite: Hindi 303 or equivalent. SUBBARAO.

305. Advanced Hindi, I. A course for advanced knowledge of spoken and written Hindi. All students are required to work at least one hour every week with a native informant and/or in the language laboratory. 1 unit. Prerequisite: Hindi 304 or consent of instructor. Y. KACHRU, SUBBARAO.

306. Advanced Hindi, II. A course for advanced knowledge of spoken and written Hindi with emphasis on modern Hindi literature and language. All students are required to work at least one hour every week with a native informant and/or in the language laboratory. 1 unit. Prerequisite: Hindi 305 or consent of instructor. Y. KACHRU, SUBBARAO.

307. Advanced Hindi, III. A course for detailed analysis of formal grammar of Hindi with concentration on readings from Hindi literature. 1 unit. Prerequisite: Hindi 306 or consent of instructor. Y. KACHRU.

308. Advanced Hindi, IV. A survey of the history of Hindi literature and readings from different periods of Hindi literature. 1 unit. Prerequisite: Hindi 307 or consent of instructor. Y. KACHRU.

309. Readings in Hindi Literature in Translation. Introduction to Hindi literature

since 1400 A.D. Concentration on major works in poetry and prose available in English translation. 1 unit. Prerequisite: Consent of instructor. Y. Kachru. Subbarao.

310. Readings in Hindi Literature in English Translation. Introduction to Hindi Literature—Modern Period. Concentration upon major works in poetry, prose, and novel available in English translation. 1 unit. Prerequisite: Consent of instructor. Y. Kachru.

Modern Greek, Swahili, and Yoruba

For courses in these languages, consult the Head of the Department of Linguistics.

MANAGEMENT

See Business Administration, page 102.

MARKETING

See Business Administration, page 102.

MATHEMATICS

(Including Statistics)

The Department of Mathematics offers graduate work leading to the Master of Arts or Master of Science in Mathematics and Doctor of Philosophy in Mathematics, Master of Science in the Teaching of Mathematics, and Master of Arts or Master of Science in Statistics and Doctor of Philosophy in Statistics. For information concerning applied mathematics, see page 292.

MATHEMATICS

For admission to full standing, a beginning graduate student must have a grade-point average of at least 3.75. Applications of students with grade-point averages below 3.75 but above 3.5 are considered on an individual basis.

A beginning graduate student should have had at least twenty-six hours of undergraduate work in mathematics besides the usual freshman courses in algebra, trigonometry, and analytic geometry, including a one-year course in calculus and at least nine semester hours of more advanced work in one or more of the fields of algebra, geometry, topology, analysis, number theory, and numerical analysis. The last requirement refers to courses equivalent to Mathematics 317-318, 323-324, 327-328, 332, 347-348, 353-354, and 387.

Master of Arts or Master of Science in Mathematics. The departmental requirements for the master's degree in mathematics are as follows: of the eight units required for the degree, at least six must be in mathematics, at least three of them in approved 400-level courses. Mathematics 347-348 and at least one other basic year sequence at or above the intermediate level, normally one of the sequences 317-318, 323-324, 327-328, 332-435, should be included. More than one-half of this last requirement should be fulfilled in previous undergraduate work. An entering student not meeting the requirements outlined in the preceding paragraph will not be able to earn a master's degree with only eight units of graduate work. A master's thesis is not required.

Master of Science in the Teaching of Mathematics. Candidates for the Master of Science in the Teaching of Mathematics must earn four units in mathematics, two units in education, and two units in electives. To meet requirements for this degree, candidates must have completed, either as prerequisites to admission or as part of their graduate program, all of the following courses or their equivalents: Mathematics 302, 303, 306, 307, 317, 318, 343,

347. A student who has not completed at least two of these courses as an undergraduate can not expect to qualify for the Master of Science in the Teaching of Mathematics in one year. Required courses in education are History and Philosophy of Education 304 and 305 and Educational Psychology 311 and 312. The electives may be in mathematics, in education, or, in exceptional cases, in other fields. Students applying for admission must have a grade-point average of 3.75. Applications of students with grade-point averages below 3.75 but above 3.5 are considered on an individual basis. The adviser for this degree is Professor Wilson M. Zaring, 303 Altgeld Hall. See pages 36 and 37.

Doctor of Philosophy in Mathematics. The departmental requirements for the Doctor of Philosophy are as follows: the major subject is to be chosen from algebra, analysis, applied mathematics, automata theory, geometry, logic, number theory, probability and statistics, topology. The student must choose internal minors from this list in such a way as to attain broad training in mathematics. If an outside minor is chosen, it must have the approval of the Department of Mathematics. The student must complete a satisfactory thesis in his major area.

Before taking the preliminary examination, the student must present sixteen units or the equivalent with the approval of the department. Of these units, at least ten units must be in 400-level mathematics courses, except that for a student with a four-unit outside minor, eight such units suffice. The preliminary examination in mathematics is based on the student's major and internal minor subjects, but is also intended to test the student's breadth of knowledge in mathematics. In the case of an outside minor, the minor department may give an independent examination, if it so chooses, or may establish other criteria for evaluation of the student's ability.

At least two 400-level courses are required for each internal minor. The following mathematics courses are typical of those which may be used to satisfy major or minor requirements, and are listed by fields. It is left to the discretion of the department, however, to decide which courses may be chosen to fulfill such requirements.

Algebra: 401-407, 415, 416, 422, 427.
Analysis: 440-450, 468, 469, 487.
Applied Mathematics: 444, 455-461, 463, 487-489.
Automata Theory: 416, 463, 465, 488, 489.
Geometry: 420, 422-428.
Logic: 410-413, 416.
Number Theory: 405, 416, 453, 454, 468, 469.
Probability and Statistics: 451, 452, 461, 463, 470, 473, 474, 478.
Topology: 431-436, 438, 439.

Furthermore, Mathematics 490 and 493 may be used for major or minor requirements in all areas, subject to the approval of the department.

Every student who intends to work toward a degree of Doctor of Philosophy in Mathematics is expected to take a written qualifying examination within one year after completing his requirements for the master's degree or within one year of his admission to graduate study in the department, whichever is later. This examination is based on topics covered in Mathematics 317, 318, 347, 348. Furthermore, each student is expected to take the preliminary examination within one year after completing sixteen units of graduate work. The department may relax these time requirements if special circumstances so warrant.

The language requirement must be met by demonstrating a reading proficiency in any two of the following three languages: French, German, and Russian.

STATISTICS

This program of study is for those who wish to concentrate on research in the theory of statistics, and to provide training in the theory and practice of statistical inference from quantitative data. It also provides an appropriate minor for those who wish to develop competence in an area of application of statistics, such as agronomy, biology, chemistry, economics, education, geology, physics, or psychology.

For admission to full standing, a beginning graduate student must have a grade-point

average of not less than 3.75. Applications of students with grade-point averages below 3.75 but above 3.5 are considered on an individual basis. The requirements for admission as a beginning graduate student in statistics are the same as those for mathematics except that at least nine hours should be chosen from courses equivalent to Mathematics 317-318, 323-324, 327-328, 332, 347-348, 353-354, 361, 363, 364, 366, 387.

Master of Arts or Master of Science in Statistics. A candidate for the master's degree in statistics, in addition to satisfying the general requirements of the Graduate College, must complete the following courses: (1) Mathematics 315 and 347, or equivalent; (2) four units of statistics of which at least two must be courses at the 400 level; (3) two units in mathematics or an area of application; (4) two units of electives approved by the adviser.

However, so long as a student fulfills the standard requirements for graduate degrees see pages 30 to 37, he may complete some of these course requirements as an undergraduate, or by any other means approved by the Department of Mathematics.

Doctor of Philosophy in Statistics. The thesis for the Doctor of Philosophy must show capacity for original contributions to the development of new statistical ideas and methods.

A candidate for the Doctor of Philosophy in Statistics, in addition to satisfying the general requirements of the Graduate College, must complete the following courses: (1) Mathematics 315 and 347, or equivalent; (2) eight units of statistics of which at least four must be courses at the 400 level; (3) four units in mathematics or an area of application, not more than two of which should emphasize training in statistics; (4) six units of electives approved by the adviser.

FACULTY

Professors: P. T. Bateman (Head of Department), F. R. Albrecht, R. G. Bartle, C. R. Blyth, W. W. Boone, P. G. Braunfeld, D. L. Burkholder, S. S. Cairns, R. W. Carroll, K. T. Chen, M. M. Day, J. L. Doob, C. W. Gear, D. B. Gillies, S. I. Goldberg, J. W. Gray, W. R. G. Haken, Mary-Elizabeth Hamstrom, M. H. Heins, F. E. Hohn, R. P. Jerrard, F. B. Knight, R. G. Langebartel, H. Levy, C. W. Mendel, D. E. Muller, H. A. Osborn, E. T. Parker, I. Reiner, J. J. Rotman, L. A. Rubel, E. J. Scott, J. L. Selfridge, M. Suzuki, G. Takeuti, T. W. Ting, H. E. Vaughan, J. H. Walter, R. A. Wijsman.

Associate Professors: J. R. Alexander, K. I. Appel, J. W. Armstrong, R. B. Ash, S. B. Bank, I. D. Berg, E. R. Berkson, R. L. Bishop, Josephine H. Chanler, H. G. Diamond, W. A. Ferguson, R. L. Finney, R. M. Fossum, L. L. Helms, S. S. Jogdeo, F. W. Kamber, R. P. Kaufman, P. A. Loeb, L. R. McCulloh, T. G. McLaughlin, J. Nievergelt, C. F. Osgood, H. Paley, A. L. Peressini, J. W. Peters, W. V. Philipp, M. Rajagopalan, R. R. Rao, D. J. S. Robinson, N. J. Rothman, Jewell E. Schubert, D. R. Sherbert, P. M. Tondeur, P. M. Weichsel, E. C. Weinberg, J. E. Wetzel, K. G. Witz, W. M. Zaring.

Assistant Professors: S. K. Aggarwal, A. Babakhanian, Felice D. Bateman, Geneva G. Belford, H. E. Benzinger, Astrid J. Berkson, B. C. Berndt, R. E. Bohrer, J. W. Brown, R. F. Craggs, L. L. Dornhoff, R. J. Faudree, G. K. Francis, W. J. Frascella, D. K. Friesen, G. S. Garfinkel, Eva W. Gray, G. J. Janusz, C. G. Jockusch, Lucretia M. Levy, H. P. Lotz, D. G. McRae, J. B. Miles, J. T. Parr, Phyllis G. Parr, N. T. Peck, C. A. Phillips, H. Porta, Irma M. Reiner, P. E. Schupp, W. F. Stout, K. B. Stolarsky, J. J. Uhl, P. D. Zvengrowski.

COURSES FOR GRADUATES

400. General Seminar. General seminar required of all graduate students who have passed the departmental written qualifying examination for the Ph.D. 0 credit.

401. Second Course in Abstract Algebra, I. The Noether isomorphism theorem for groups; permutation groups; simplicity of the alternating group; Jordan-Holder theorem; Euclidean rings; fundamental theorem of Galois theory. 1 unit. Prerequisite: Mathematics 317 and 318.

402. Second Course in Abstract Algebra, II. Wedderburn theorem on semi-simple rings; fundamental theorem of finitely generated Abelian groups (with application to canonical forms for matrices); Krull-Schmidt theorem; tensor products; exterior algebra. 1 unit. Prerequisite: Mathematics 401.

403. Theory of Rings. Ideal theory in commutative rings; structure of noncommutative rings. 1 unit. Prerequisite: Mathematics 401, 402, or equivalent.

404. Group Theory. Structure of groups, derived groups, nilpotence and solvability, extensions and products. 1 unit. Prerequisite: Mathematics 401, 402, or equivalent.

405. Algebraic Number Theory. Further development of the theory of fields covering topics from valuation theory, ideal theory, units in algebraic number fields, ramification, function fields, local class field theory. 1 unit. Prerequisite: Mathematics 401, 402, or equivalent.

406. Homological Algebra. Definition and properties of the functors Ext and Tor; projective, injective, and flat modules; group extensions; dimensions of rings, Hilbert theorem on syzygies. 1 unit. Prerequisite: Mathematics 402 or equivalent.

407. Group Representation Theory. Representation of groups by linear transformations, group algebras, character theory, modular representations. 1 unit. Prerequisite: Mathematics 401, 402, or equivalent.

410. Logical Foundations of Mathematics, I. Develops the predicate calculus of first order as a framework for metamathematical investigations. Considers the elementary aspects of model theory; the completeness and compactness theorems, Lowenheim-Skolem theorem, Craig interpolation theorem, elementary facts about ultraproducts. Prerequisite: Mathematics 314, or 317, or 341, or Philosophy 333, or consent of instructor.

411. Logical Foundations of Mathematics, II. Axiomatic number theory and the incompleteness results of Godel, Rosser and Tarski, Church's Theorem, and the elements of undecidability theory. Further topics selected by the instructor. Prerequisite: Mathematics 410.

412. Recursive Function Theory. Introduction to recursive functions, study of properties of recursive and recursively enumerable sets, degrees of unsolvability, and the implications of the Church-Turing thesis. 1 unit. Prerequisite: Mathematics 410 or consent of instructor.

413. Set Theory. Zermelo-Fraenkel axiomatic set theory; basic concepts in set theory such as ordinal, cardinal, and rank are considered. 1 unit. Prerequisite: Mathematics 410.

415. Advanced Topics in the Theory of Groups. 1 unit. Prerequisite: Consent of instructor.

416. Advanced Topics in Abstract Algebra. 1 unit. Prerequisite: Consent of instructor.

420. Projective Geometry. 1 unit. Prerequisite: Mathematics 328.

422. Algebraic Geometry. 1 unit. Prerequisite: Mathematics 328.

423. Differentiable Manifolds. Definition and properties of differentiable manifolds and maps, introducing vector fields, tangent bundles, differential forms, exterior derivatives, foliations. 1 unit. Prerequisite: Mathematics 323 and 324, or consent of instructor.

424. Riemannian Geometry. Local and global properties of Riemannian manifolds. 1 unit. Prerequisite: Mathematics 423.

425. Linear Analysis on Manifolds, I. Study of topological invariants of differentiable and complex manifolds. 1 unit. Prerequisite: Mathematics 423 and 431, or consent of instructor.

426. Linear Analysis on Manifolds, II. Continuation of Mathematics 425. 1 unit. Prerequisite: Mathematics 425.

427. Lie Groups. Study of groups which are also differentiable manifolds. 1 unit. Prerequisite: Mathematics 423.

428. Topics in Geometry. 1 unit. Prerequisite: Consent of instructor.

430. Elementary Geometry from a Modern Viewpoint. Designed for secondary school teachers of mathematics. Primary purpose of the course is to discuss critically the logical structure and content of Euclidean geometry from the modern point of view. Consideration is given to the historical development of the modern approach. 1 unit. Prerequisite: One year of experience in the teaching of high school mathematics; consent of instructor.

431. Algebraic Topology, I. Homological algebra techniques, simplicial and singular homology, fundamental group and covering spaces, applications. 1 unit. Prerequisite: Mathematics 318 and 332, or consent of instructor.

432. Algebraic Topology, II. Continuation of Mathematics 431. Axiomatic homology theory, fibrations and cofibrations, CW-complexes, co-homology products, other topics. 1 unit. Prerequisite: Mathematics 431.

433. Fiber Spaces and Characteristic Classes. Continuation of Mathematics 432. Study of fiber bundles and their associated characteristic classes; applications to geometric problems. 1 unit. Prerequisite: Mathematics 432.

434. Polyhedral Topology. Topology in the piecewise linear category. 1 unit. Prerequisite: Mathematics 431 and 435.

435. General Topology, I. Study of topological spaces and maps, including Cartesian products, identifications, connectedness, compactness, uniform spaces, function spaces. 1 unit. Prerequisite: Mathematics 332 or consent of instructor.

436. General Topology, II. Continuation of Mathematics 435. 1 unit. Prerequisite: Mathematics 435.

438. Topics in Topology. 1 unit. Prerequisite: Consent of instructor.

439. Seminar in Topology. 1 unit. Prerequisite: Consent of instructor.

440. Theory of Functions of a Complex Variable, I. Application of the elementary theory is made to the study of conformal mappings, Riemann surfaces, entire and meromorphic functions. 1 unit. Prerequisite: Mathematics 348 or consent of instructor.

441. Real Analysis, I. Lebesgue measure on the real line, integration and differentiation of real functions, elementary applications to harmonic analysis. 1 unit. Prerequisite: Mathematics 347 or equivalent.

442. Real Analysis, II. Metric spaces, introduction to functional analysis, integration on general measure spaces. 1 unit. Prerequisite: Mathematics 441.

443. Ordinary Differential Equations. Existence, uniqueness, and continuation of solutions; topics selected from: the theory of linear differential operators, Sturm-Liouville theory, stability theory, qualitative theory of differential equations. 1 unit. Prerequisite: Mathematics 347 and a first course in ordinary differential equations.

444. Partial Differential Equations. 1 unit. Prerequisite: Consent of instructor.

445. Theory of Functions of a Complex Variable, II. 1 unit. Prerequisite: Mathematics 332 and 440, or consent of instructor.

446. Hilbert Space. Geometrical properties of Hilbert spaces; linear operators; the spectral theory for self adjoint and related operators. 1 unit. Prerequisite: Mathematics 442.

447. Banach Spaces. Geometrical properties of Banach spaces; bounded linear operators; applications to analysis; linear topological spaces. 1 unit. Prerequisite: Mathematics 442.

448. Harmonic Analysis. Locally compact groups, Haar measure, Fourier analysis, and Tauberian theorems. 1 unit. Prerequisite: Mathematics 442.

449. Normed Rings. Properties of normed rings; representation as rings of continuous functions or rings of bounded operators; applications to spectral theory, harmonic analysis, etc. 1 unit. Prerequisite: Mathematics 318 and 446 or 447.

450. Ordered Spaces. A study of ordered topological vector spaces and vector lattices and positive operators. 1 unit. Prerequisite: Mathematics 442 and 447.

451. Theory of Probability. 1 unit. Prerequisite: Mathematics 442.

452. Theory of Probability. 1 unit. Prerequisite: Mathematics 451.

453. Analytic Theory of Numbers. 1 unit. Prerequisite: Mathematics 317 and 348.

454. Analytic Theory of Numbers. 1 unit. Prerequisite: Mathematics 453.

455. Mathematical Methods of Physics. 1 unit. Prerequisite: Mathematics 348.

456. Mathematical Methods of Physics. 1 unit. Prerequisite: Mathematics 455.

457. Advanced Numerical Analysis. Same as Computer Science 457. Ordinary differential equations: existence theory of Picard, one-step and multi-step methods, discretization error, convergence, stability, boundary value problems; integral equations. 1 unit. Prerequisite: Computer Science or Mathematics 387 or consent of instructor.

458. Numerical Solution of Partial Differential Equations. Same as Computer Science 458. The numerical solution of initial and boundary value problems for partial differential equations; topics include the approximation of differential operators by difference operators, the solution of large systems of linear equations by iterative methods, and discussion of convergence and numerical stability. 1 unit. Prerequisite: Computer Science or Mathematics 457, or consent of instructor.

459. Topics in Hydrodynamics. 1 unit. Prerequisite: Consent of instructor.

460. Relativity and Cosmology. Same as Astronomy and Physics 424. Elements of tensor calculus and Riemannian geometry; special relativity; Lorentz transformations, equivalence of mass and energy; general relativity and the gravitational field of the sun; galaxies and cosmology. 1 unit. Prerequisite: Consent of instructor. McVittie.

461. Applied Stochastic Processes. Introduction to topics such as spectral analysis, filtering theory, and prediction theory of stationary processes; Markov chains and Markov processes. 1 unit. Prerequisite: Mathematics 346 and 347.

463. Information Theory. Same as Computer Science and Electrical Engineering 463. Mathematical models for information channels and sources; existence theorems for and construction of error-correcting codes. 1 unit. Prerequisite: Mathematics 361.

465. Topics in Automata Theory. Same as Computer Science and Electrical Engineering 465. 1 unit. Prerequisite: Computer Science, Mathematics, or Electrical Engineering 392, or consent of instructor.

468. Topics in Analysis. 1 unit. Prerequisite: Consent of instructor.

469. Seminar in Analysis. 1 unit. Prerequisite: Consent of instructor.

470. Statistical Decision Functions. Statistics from the point of view of decision-making; introduction to the theory of games; minimax and other decision functions; techniques for determining optimal decision functions; applications to nonsequential and sequential decision-making in practice. 1 unit. Prerequisite: Consent of instructor.

473. The Theory of Testing Hypotheses. Methods of constructing statistical tests which have optimum properties in small samples; the principles of invariance, unbiasedness and similarity; most stringent tests and minimax tests. 1 unit. Prerequisite: Consent of instructor.

474. The Theory of Estimation. Methods of constructing uniformly minimum variance unbiased estimates; minimax estimation; estimation by confidence sets. 1 unit. Prerequisite: Consent of instructor.

478. Topics in Statistics. 1 unit. Prerequisite: Consent of instructor.

487. Theory of Approximation. Same as Computer Science 487. General approximation

theory in normed linear spaces with primary emphasis on functions defined on an interval, and periodic functions; existence and uniqueness theorems; characterization of Chebyshev approximants; degree of approximation; interpolation with emphasis on the quality of interpolants as approximants; use of approximations in computing. 1 unit. Prerequisite: Mathematics 318, 348, or consent of instructor.

488. Topics in Applied Mathematics. 1 unit. Prerequisite: Consent of instructor.

489. Seminar in Applied Mathematics. 1 unit. Prerequisite: Consent of instructor.

490. Reading Course. 1 to 2 units. Prerequisite: Consent of instructor.

493. Proseminar. An introduction to the methods and tools of mathematical research. The work of the course consists in the solution by the students of assigned problems in various fields of mathematics and the presentation of these solutions in both written and oral form. 1 unit. Prerequisite: Mathematics 347; credit or registration in Mathematics 348.

499. Thesis Research. 0 to 4 units. Prerequisite: Consent of instructor. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Theory of Sets and the Real Number System. This course deals with elementary naive set theory and the development of the integers, the rational numbers, and the real numbers; principal emphasis is upon the mathematical needs of the secondary teacher. 1 unit. Prerequisite: Mathematics 140 or 141 or 145, or equivalent, or consent of instructor.

301. Fundamental Concepts of Algebra. 1 unit. Prerequisite: Mathematics 140 or 141 or 145, or equivalent, or consent of instructor.

302. Topics in Geometry. Historical development of geometry, including tacit assumptions made by Euclid, Euclid's Fifth Postulate and its equivalents, and the discovery of non-Euclidean geometries; geometry as a mathematical structure; finite geometries; geometry as a study of invariants of set transformations; projective geometry; applications of group theory to geometry; vector geometry. 1 unit. Prerequisite: Mathematics 140 or 141 or 145, or equivalent, or consent of instructor.

303. Advanced Aspects of Euclidean Geometry. Selected topics from geometry as for example, circumcircle, nine-point circle, theorem on centroid and orthocenter, the construction of regular figures, isometries in the plane and space, rotations and translations, fixed points, ordered and affine geometries, geometry of inversive plane. 1 unit. Prerequisite: Mathematics 140 or 141 or 145, or equivalent, or consent of instructor.

305. Teachers' Course. A study of some special teaching problems in arithmetic, algebra, geometry, and trigonometry. Teaching procedures for important topics in these subjects are discussed in relation to their foundations in mathematics and logic. Topics suitable for presentation for superior high school students are also considered. ½ or 1 unit. Prerequisite: Mathematics 140 or 141 or 145, or equivalent, or consent of instructor.

306. Selected Mathematical Topics for Secondary School Teachers, I. This course deals with the teaching of the following topics in secondary school mathematics: symbolism and numbers; directed numbers; variables; equations (linear, quadratic, systems); sets; graphs; bases of enumeration; functions; critical examination of these topics. ½ or 1 unit. Prerequisite: One year of secondary school teaching in mathematics or consent of instructor.

307. Selected Mathematical Topics for Secondary School Teachers, II. This course deals with the teaching of the following topics in high school mathematics: variables in geometry; logic analysis of geometrical propositions; equivalence relations in geometry including congruence and similarity; geometry in the coordinate plane; cosine and sine as real valued functions of real arguments; a comparison of these functions with those ordinarily taught in the high school; symmetry; periodicity; evenness and oddness; exponential and logarithmic functions. ½ or 1 unit. Prerequisite: One year of secondary school teaching in mathematics or consent of instructor.

311. Advanced Algebra. For students interested in actuarial science, statistics, or teacher training in mathematics. 1 unit. Prerequisite: Mathematics 140 or 141 or 145, or equivalent, or consent of instructor.

312. Advanced Algebra. For students interested in actuarial science, statistics, or teacher training in mathematics. 1 unit. Prerequisite: Mathematics 140 or 141 or 145, or equivalent, or consent of instructor.

314. Introduction to Set Theory and Mathematical Logic. In general, this course supplies the set-theoretic and logical preliminaries for graduate work in mathematics. Contents: sets, relations, and mappings; the notions of constant and variable; the integers; cardinal and ordinal numbers; Zorn's Lemma; the real numbers; informal account of the propositional calculus and first order functional calculus; informal account of various axiomatic theories. 1 unit. Prerequisite: Mathematics 140 or 141 or 145, or equivalent.

315. Linear Transformations and Matrices. 1 unit. Prerequisite: Mathematics 140 or 141 or 145, or equivalent.

317. Introduction to Higher Algebra. 1 unit. Prerequisite: Mathematics 140 or 141 or 145, or equivalent.

318. Introduction to Higher Algebra. 1 unit. Prerequisite: Mathematics 317.

323. The Elements of Geometry and Topology, I. Introduction to geometrical techniques relevant to topology and differential geometry. Curves from four viewpoints: topology, differential geometry, combinations, algebraic geometry. Local differential geometry of surfaces. 1 unit. Prerequisite: Mathematics 343.

324. The Elements of Geometry and Topology, II. Continuation of Mathematics 323. Three viewpoints of surfaces are studied and interrelated: topology, differential geometry, and combinations (algebraic topology). 1 unit. Prerequisite: Mathematics 323.

327. Introduction to Projective Geometry, I. 1 unit. Prerequisite: Mathematics 315 or consent of instructor.

328. Introduction to Projective Geometry, II. 1 unit. Prerequisite: Mathematics 327.

332. Introduction to Set Theory and Topology. Informal set theory, cardinals, ordinals, Zorn's Lemma, axiom of choice, topology of metric spaces, introduction to general topological spaces, and other topics. 1 unit. Prerequisite: Credit or registration in Mathematics 347.

341. Differential Equations. 1 unit. Prerequisite: Mathematics 140 or 141 or 145, or equivalent.

342. Differential Equations. 1 unit. Prerequisite: Mathematics 341.

343. Advanced Calculus. 1 unit. Prerequisite: Mathematics 140 or 141 or 145, or equivalent.

345. Differential Equations and Orthogonal Functions. 1 unit. Credit is not given for both Mathematics 345 and 349. Prerequisite: Mathematics 140 or 141 or 145, or equivalent.

346. Complex Variables and Applications. For students who desire a working knowledge of complex variables. Covers the standard topics and in addition gives an introduction to integration by residues, the argument principle, conformal maps, Laplace transforms, and potential fields. Students desiring a systematic development of the foundations of the subject should take Mathematics 348. Credit is not given for both Mathematics 346 and 348. 1 unit. Prerequisite: Mathematics 343 or consent of instructor.

347. Introduction to Higher Analysis: Real Variables. 1 unit. Prerequisite: Mathematics 343 or consent of instructor.

348. Introduction to Higher Analysis: Complex Variables. 1 unit. Credit is not given for both Mathematics 346 and 348. Prerequisite: Mathematics 347.

349. Differential Equations and Orthogonal Functions. An honors course for students with superior mathematical ability. Credit is not given for both Mathematics 349 and

345. 1 unit. Prerequisite: Grade of B or higher in Mathematics 347; and, for undergraduates, registration in Mathematics 249.

350. Topics in Pure Mathematics. This is a survey course in pure mathematics for secondary school mathematics teachers. It deals with topics in number theory, topology, and analysis. 1 unit. Prerequisite: Consent of instructor.

351. Topics in Applied Mathematics. This is a survey course in applied mathematics for secondary school mathematics teachers. It deals with topics in the application of matrices to physical and social sciences, applications of Boolean algebra, game theory. 1 unit. Prerequisite: Consent of instructor.

352. Multivariate Real Analysis. Rigorous treatment of the calculus of functions of several real variables. Topics covered: differentials, maxima and minima, Lagrange multipliers, transformation of multiple integrals, Jacobians implicit function theorems, line and surface integrals, Stokes' theorem, vector analysis. 1 unit. Prerequisite: Mathematics 347.

353. Elementary Theory of Numbers. 1 unit. Prerequisite: Mathematics 140 or 141 or 145, or equivalent.

354. Elementary Theory of Numbers. 1 unit. Prerequisite: Mathematics 317 or 353.

357. Mathematical Models in the Social Sciences. Uses many models drawn from the social sciences to motivate, illustrate, and give a unified development of topics in the following areas: linear algebra, graph theory, Markov chains, and linear and nonlinear systems of difference equations. 1 unit. Prerequisite: Mathematics 134 or equivalent.

361. Theory of Probability. 1 unit. Prerequisite: Mathematics 140 or 141 or 145, or equivalent.

362. Finite Differences. 1 unit. Prerequisite: Mathematics 140 or 141 or 145, or equivalent.

363. Advanced Statistics. 1 unit. Prerequisite: Mathematics 140 or 141 or 145, or equivalent.

364. Advanced Statistics. 1 unit. Prerequisite: Mathematics 363.

365. Analysis of Variance. Estimation and hypotheses testing in linear models; one-, two- and higher-way layouts; incomplete layouts; analysis of covariance; random effects models and mixed models. 1 unit. Prerequisite: Mathematics 364 and 315. May be taken concurrently with Mathematics 364.

366. Theory of Probability. Continuation of Mathematics 361. Topics covered may include random walks, Markov chains, branching processes, birth and death processes, and theory of queues. 1 unit. Prerequisite: Mathematics 361 or 363.

371. Actuarial Theory. 1 unit. Prerequisite: Mathematics 140 or 141 or 145, or equivalent. PETERS.

372. Actuarial Theory. 1 unit. Prerequisite: Mathematics 371.

381. Vector and Tensor Analysis. 1 unit. Prerequisite: Mathematics 343 or equivalent, or consent of instructor.

382. Vector, Tensor, and Matrix Methods in Applied Mathematics. 1 unit. Prerequisite: Mathematics 381 or consent of instructor.

383. Linear Programming. Systems of linear inequalities, the standard canonical and general linear problems, simplex method of solution. 1 unit. Prerequisite: One year of calculus.

386. Laplace Transforms. 1 unit. Prerequisite: Mathematics 343.

387. Numerical Analysis. Same as Computer Science 387. The main topics discussed in this course are error analysis and algorithms for: the solution of equations; the computation of eigenvalues and eigenvectors; numerical quadrature; numerical approximation of functions. 1 unit. Prerequisite: Computer Science or Mathematics 287; a knowledge of elementary matrix algebra, or consent of instructor.

388. Mathematical Methods in Engineering and Science. 1 unit. Prerequisite: Mathematics 343.

391. Boolean Algebra and Switching Theory. Same as Computer Science and Electrical Engineering 391. Boolean algebra with applications to sets, logic, electronic and relay combinational circuits: Karnaugh and Quine-McCluskey minimization procedures with applications; introduction to sequential circuits. ½ or 1 unit. Prerequisite: Consent of instructor.

392. Introduction to Automata Theory. Same as Computer Science and Electrical Engineering 392. Semigroups, partially ordered sets, and other algebraic systems: asynchronous machines; abstract synchronous machines and their properties; regular sets; decomposition theory. ½ or 1 unit. Prerequisite: Computer Science, Mathematics, or Electrical Engineering 391, or consent of instructor.

MATHEMATICS (APPLIED)

A wide variety of courses in applied mathematics, covering among others the fields of mechanics of particles and of rigid bodies, the mechanics of continuous media, electromagnetic theory and mathematical methods, is offered by various graduate departments in the sciences and engineering. A graduate student interested in applied mathematics should register as a major in the department of his choice. In consultation with his adviser he should plan a basic course of study which will serve as preparation for subsequent specialization and research in the theoretical aspects of one or more of the following fields: aerodynamics and hydrodynamics, astronomy, elasticity and plasticity, electrical theory, mathematics, mathematical meteorology, or the mathematical problems related to digital computer use and design.

MECHANICAL AND INDUSTRIAL ENGINEERING

The Department of Mechanical and Industrial Engineering offers work leading to the Master of Science and Doctor of Philosophy. Advanced study and professional training are offered in the general fields of power, design, production, and industrial engineering.

The prerequisite for graduate work in mechanical engineering is the equivalent of the undergraduate course requirements of the Bachelor of Science in mechanical engineering at the University of Illinois, with a grade-point average of at least 4.0. The applications of those with grade-point averages below 4.0 but above 3.6 are individually reviewed by the graduate committee and admission is granted if credentials are satisfactory. Students who have obtained graduate credit in some other university may apply for admission provided their undergraduate records meet the above requirements and their grade-point averages in graduate work are at least 4.0.

A minimum of eight units must be completed for the master's degree when a thesis is included. The requirement of a master's thesis may be waived, but a minimum of nine units is then required.

For further information see *Notes on Graduate Study*, available from the Department of Mechanical and Industrial Engineering, 144 Mechanical Engineering Building. Correspondence concerning graduate studies should be addressed to the departmental chairman of the graduate committee, Professor Seichi Konzo.

FACULTY

Professors: H. H. Korst (Head of Department), H. D. Bareither, J. W. Bayne, E. L. Broghamer, B. T. Chao, J. C. Chato, W. L. Chow, L. E. Doyle, G. W. Harper, E. F. Hebrank, J. A. Henry, R. G. Hering, W. L. Hull, S. Konzo, J. L. Leach, R. J. Martin, J. C. Miles, L. C. Pigage, E. I. Radzimovsky, F. Seyfarth, S. L. Soo, W. F. Stoecker, K. J. Trigger.

Associate Professors: A. L. Addy, R. W. Adkins, W. E. Bair, A. M. Clausing, M. I. Dessouky, B. A. Hertig, B. G. Jones, D. H. Offner, L. D. Savage, Jr., R. P. Strout, B. F. von Turkovich, R. A. White.
Assistant Professors: B. P. Bardes, J. Duncan, R. E. Klein, C. S. Larson, F. A. Morrison, C. O. Pedersen, T. W. Petrie, J. J. Stukel, R. A. Wallhaus.

Mechanical Engineering

COURSES FOR GRADUATES

401. Thermodynamics and Transport Properties. Thermodynamics and microscopic considerations for the prediction of properties. Caratheodory principle, relations among properties; microscopic considerations and statistical methods; thermodynamic and transport properties; fluctuation and non-equilibrium thermodynamics. 1 unit. Prerequisite: Mechanical Engineering 301 or consent of instructor. Morrison, Soo.

402. Non-Equilibrium Processes. Dynamics and thermodynamics of multiphase and multicomponent systems with special relevance to air pollution control and energy conversion; relaxation phenomena, general motion of systems of disparate elemental masses, diffusion in gravitational and electric fields, boundary layer motion with mass transport, dispersion and collection of particular matter, transport with surface reactions. 1 unit. Prerequisite: Mechanical Engineering 301, 303, or consent of instructor.

403. Fundamentals of Combustion. Same as Aeronautical and Astronautical Engineering 438. Fundamentals of kinetic theory, transport phenomena, chemical equilibria, and reaction kinetics; flames, their gross properties, structure, and gas dynamics including oscillatory and turbulent burning; solid and liquid propellant combustion; one-dimensional detonation theory including structure and initiation; three-dimensional and other complex detonation waves; supersonic burning. 1 unit. Prerequisite: Mechanical Engineering 305 or Aeronautical and Astronautical Engineering 213.

404. Gas Dynamics. Introduction to theoretical gas dynamics; properties of compressible real fluids, fundamental laws and basic equations for subsonic and supersonic steady and nonsteady motion; interpretations and use in one- and multi-dimensional problems. 1 unit. Prerequisite: Differential equations, thermodynamics, fluid mechanics. Addy, Chow, Korst.

405. Convective Heat Transfer. Fundamentals of convective heat transfer; calculation of heat transfer within conductor and over submerged objects for laminar and turbulent flow; natural convection; film condensation and boiling; liquid metals. 1 unit. Prerequisite: Mechanical Engineering 306 or consent of instructor. Chao, Clausing, Hering.

406. Heat Conduction in Solids. Fundamentals of heat conduction in isotropic and anisotropic solids; methods of solution to steady and transient heat conduction problems in one, two, and three dimensions; internal heat sources; periodic flow of heat; problems involving phase change; approximate analytical techniques. 1 unit. Prerequisite: Mechanical Engineering 306, Mathematics 346, or consent of instructor. Chao, Hering.

407. Selected Topics in Gas Dynamics. Theoretical analysis of nonsteady processes including scavenging, pulse jet, shock tube, and complex compressor. Includes an introduction to high velocity laboratory techniques. 1 unit. Prerequisite: Mechanical Engineering 404. Chow, Korst.

408. Laboratory Investigation in Thermodynamics. Special investigations involving thermodynamics analysis, thermodynamic properties, and performance of physical and chemical systems. $\frac{1}{2}$ to $1\frac{1}{2}$ units. Prerequisite: One-year course in thermodynamics; one half-year course in power laboratory. Bair, Morrison, Soo, Stukel.

409. Laboratory Investigations in Fluid Flow, Heat Transfer, and Combustion. Special investigation in flow, metering, heat transfer, heat exchanger performance and

design. ½ to 1½ units. Prerequisite: Courses in thermodynamics and fluid mechanics. ADDY, BAIR, CHAO, CHOW, CLAUSING, HERING, JONES, KORST, PETRIE, SAVAGE, WHITE.

410. Thermal Radiation. Fundamentals of radiant energy transport in absorbing and non-absorbing media; pyrometry; applications to selected problems involving combined energy transport mechanisms. 1 unit. Prerequisite: Mechanical Engineering 306 or consent of instructor. CHAO, HERING.

421. Environmental Control. Same as Architecture 421. Design of environmental systems for buildings. Integration of mechanical, structural, and architectural demands, in lectures and through a semester design project. 1 unit. Prerequisite: Undergraduate courses in heat transfer and fluid mechanics. STOECKER.

423. Thermal Systems. Steady-state simulation and optimization of thermal systems, dynamic performance, and probabilities in system design. 1 unit. Prerequisite: Mechanical Engineering 323. STOECKER.

428. Investigations in Thermal Systems. Investigations in the modeling, simulation, and optimization of thermal systems such as power generating, heating and cooling, and thermal processing systems. ½ to 1½ units.

429. Investigations in Environmental Control. Investigations in heating, ventilating, air conditioning, and human comfort. ½ to 1½ units.

432. Theory of Rotary Compressors. Thermodynamical and mechanical fundamentals, compression with and without cooling, classification of compressors, similarity considerations and characteristics, principles of and computations for radial compressors, improvement in performance of integrating parts; axial flow compressors: lattice and airfoil theory; change in operating conditions of turbo-compressors; regulation; rotary positive blowers. 1 unit. Prerequisite: Mechanical Engineering 205, 206, and 212; or Theoretical and Applied Mechanics 232; or Aeronautical and Astronautical Engineering 211. KORST.

438. Laboratory Investigations in Power Machinery. Special investigations in power machinery, such as turbines, engines, fans, and compressors. ½ to 1½ units. Prerequisite: One-year course in power laboratory. HEBRANK, HULL, STROUT.

441. Machine Design. A technical application course designed to focus the previously acquired design experience on the creative problem of developing machines to perform specified functions; proper considerations of manufacturing processes involved; checking of all parts for stress, wear, vibration, fatigue, etc. 1 unit. Prerequisite: Undergraduate course in dynamics of machines; one year of machine design. ADKINS.

442. Linkage Synthesis. Geometry of constrained motion in two and three dimensions; application of mathematical and other techniques to the synthesis of mechanisms. 1 unit. Prerequisite: Mechanical Engineering 342 or consent of instructor. BROGHAMER.

443. Dynamics of Machinery. Complementary to the undergraduate course and devoted to a more detailed study of velocities, accelerations, and forces in machine parts having reciprocating, rotating, and combined motions; balancing, flywheels; special topics. 1 unit. Prerequisite: Undergraduate course in dynamics of machines; one year of machine design. BROGHAMER, LARSON.

445. Design of Internal Combustion Engines. Detailed study of the design of the internal combustion engine; gas-pressure and inertia-force diagrams; determination of bearing loads; torsional vibration analysis; stress determinations and design of important parts, including piston, connecting rod, crankshaft, flywheel, valve mechanism, and cam layout. 1 unit. Prerequisite: Undergraduate courses in dynamics of machines and in internal combustion engines; one year of machine design. HULL.

448. Laboratory Investigations in Machine Design. Special investigations in machine design. ½ to 1½ units. ADKINS, BROGHAMER, LARSON, OFFNER, RADZIMOVSKY.

451. Theory of Metal Cutting. A study of the theoretical factors involved in metal cutting and forming; basic mechanics of chip formation, friction, surface damage and finish;

temperatures and temperature distribution during cutting; wear and tool-work compatibility. Analysis of experimental data; critical review of pertinent literature and special topic assignments. 1 unit. Prerequisite: Undergraduate course in principles of metal cutting and heat treatment of metals or physical metallurgy. TRIGGER.

452. Deformation and Mechanical Processing of Metals. Theoretical and experimental aspects of deformation and mechanical processing of metals. Plastic deformation; fracture and fatigue; impact stresses and stress waves in metals; thermal and residual stresses; plastic forming of metals and its influence on the properties. 1 unit. Prerequisite: Mechanical Engineering 451; Metallurgical Engineering 408. VON TURKOVICH.

458. Laboratory Investigations in Production. Special investigations in field of production, particularly in materials processing, metal cutting, and production engineering. ½ to 1½ units. BARDES, DOYLE, KLEIN, LEACH, TRIGGER, VON TURKOVICH.

493. Seminar. Required of all M.S. candidates. Presentation and discussion of significant developments in mechanical engineering. 0 credit. KONZO.

499. Thesis Research. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Thermodynamics. Basic considerations of the three laws of thermodynamics; elementary statistical principles for the prediction of properties of pure substances and mixtures; transport properties, electric and magnetic systems. ¾ or 1 unit. Prerequisite: Mechanical Engineering 206 or equivalent; consent of instructor. SOO.

302. Nuclear Power Engineering. Same as Nuclear Engineering 302. Principles of release and utilization of fission energy in nuclear power engineering, including such topics as: fission processes and controlled chain reactions; nuclear reactor types, design principles and operational characteristics; power reactor design criteria; radiation hazards and radioactive waste treatment; economics; and other applications such as propulsion and research reactors. 1 unit. Prerequisite: Consent of instructor. JONES.

303. Dynamics of Aerosols and Hydrosols. Theory and application of the basic relations of fluid dynamics, thermodynamics, and heat transfer to the motion of aerosols and hydrosols, with application to problems in air and water pollution. 1 unit. Prerequisite: Senior or graduate standing.

304. Direct Energy Conversion. Direct conversion of chemical, nuclear, and solar energies into electricity by electrochemical, thermionic, thermoelectric, photoelectric, photochemical, ferroelectric, magnetohydrodynamic, and plasma systems. ¾ or 1 unit. Prerequisite: Mechanical Engineering 301 or consent of instructor; Mathematics 345. SOO.

305. Thermodynamics of High-Velocity Flow. The thermodynamics of gases during high-velocity flow within enclosed channels using Mach number as the fundamental variable; analyses of the basic flow equations, effects of friction and plane shock theory; application to thermodynamic cycles involving nozzles, diffusers. compressors, combustion, and turbines. ¾ or 1 unit. Prerequisite: Mechanical Engineering 206, or 211, or consent of instructor. ADDY, CHOW, WHITE.

306. Industrial Heat Transfer. Theory and application of numerical, analogical, and experimental methods to selected heat transfer problems; application of principles of convection, condensation, and boiling heat transfer to design of heat exchange equipment. 1 unit. Prerequisite: Undergraduate courses in fluid mechanics and heat transfer. CLAUSING, HERING.

309. Experimental Gas Dynamics. Experimental investigation of problems in the field of compressible fluid flow within enclosed channels. 1 unit. Prerequisite: Mechanical Engineering 211, or 305, or consent of instructor. ADDY, CHOW, WHITE.

311. Instrumentation and Measurements. Same as Agricultural Engineering 311. Accuracy, precision, and statistical consideration of measurement data; dynamics of measurement; displacement, velocity, acceleration, force, torque, pressure, and tem-

perature measurements; mechanical impedance; measurements on fluids; instrumentation systems. 3/4 or 1 unit. Prerequisite: Senior standing in engineering or science. STROUT.

312. Theory of Controls. Introduction to the theory of controls. Dynamical analysis of physical systems; steady-state operations; graphical and analytical methods of analysis; applications. 3/4 or 1 unit. Prerequisite: Consent of instructor. KLEIN, VON TURKOVICH.

314. Lubrication. The theoretical basis of lubrication; hydrodynamic bearing theory; properties of lubricants; methods of testing; lubrication methods and appliances; study of the lubrication requirements of machines of many kinds. 3/4 or 1 unit. Prerequisite: Undergraduate courses in machine design and fluid mechanics. ADKINS, OFFNER, RADZIMOVSKY.

323. Design of Thermal Systems. Selection of components in fluid- and energy-processing systems to meet system performance requirements, computer-aided design, system simulation, optimization techniques, investment economics, and statistical combinations of operating conditions. 3/4 or 1 unit. Prerequisite: Mechanical Engineering 206, 211, and 213. STOECKER.

332. Theory of Internal Combustion Engines. Analysis of reciprocating engine cycle including thermodynamics and combustion and taking into consideration effects of fuel-air mixture, variable specific heats, chemical equilibrium and dissociation, and heat losses; flow through manifolds and valves; factors affecting breathing and scavenging; supercharging; bearings, lubrication, and function; effects of variables on performance. 3/4 or 1 unit. Prerequisite: Undergraduate course in internal combustion engines or consent of instructor. HULL.

341. Engineering Analysis and Design. Correlation of previously acquired design experience with the creative problems of synthesis and analysis that depend upon design judgment. 3/4 or 1 unit. Prerequisite: Mechanical Engineering 271 or consent of instructor. ADKINS, BAYNE, BROGHAMER.

342. Kinematic Analysis and Synthesis. Geometry of constrained motion; application of mathematical and other techniques to the kinematic analysis and synthesis of mechanisms. 3/4 or 1 unit. Prerequisite: Undergraduate course in kinematics or consent of instructor. BROGHAMER.

343. Dynamics of Machinery. A course complementary to the undergraduate course with emphasis on the analytical approach to the study of dynamic forces in machines, balancing, critical speeds, shaft vibrations, governors, and gyroscopes. 3/4 or 1 unit. Prerequisite: Mechanical Engineering 221 or consent of instructor. BROGHAMER.

388. Machine Tool Systems Analysis. A study of the components, their analysis and synthesis in machine tool systems; power components, precision motion, dynamic response of machine skeleton, linear and nonlinear conditions, control elements, and computer control of machines. 3/4 or 1 unit. Prerequisite: Mechanical Engineering 186, 271, or consent of instructor. VON TURKOVICH.

Industrial Engineering

COURSES FOR GRADUATES

401. Scientific Management, I. Same as Business Administration 401. A study of modern management principles on the basis of quantitative methods, concentrating on such operation research techniques as nonlinear and dynamic programming and queueing theory. 1 unit. Prerequisite: Industrial Engineering 386 and Mathematics 361, or consent of instructor.

402. Scientific Management, II. Same as Business Administration 402. A systems approach to industrial problems involving inventory control, scheduling and line balancing, maintenance and investment theory; application of formally accumulated knowledge of op-

eration research techniques. Problems from industry are assigned to small teams of students. 1 unit. Prerequisite: Industrial Administration or Industrial Engineering 401; background in computer technology or consent of instructor.

416. Design of Construction and Industrial Operations, I. Same as Civil Engineering 416. Conceptual development of a systems design procedure for optimal design of construction and industrial operations; general forms required for critical path networks, linear programs, theory of queues and inventory models required for systems design; design evaluation and control models. 1 unit. Prerequisite: Bachelor of Science in civil or industrial engineering; credit or registration in Mathematics 363; or consent of instructor.

417. Design of Construction and Industrial Operations, II. Same as Civil Engineering 417. Continuation of Industrial Engineering 416. 1 unit. Prerequisite: Industrial Engineering or Civil Engineering 416; credit or registration in Mathematics 315; or consent of instructor.

453. Work Measurement. A study of special problems of line balance, interference, and automation work loads as required to establish work standards (or production standards). 1 unit. Prerequisite: Industrial Engineering 332. PIGAGE.

454. Production Engineering. Advanced consideration of production engineering principles as related to cost analysis and reduction, control of flow of work in manufacture, evaluation of performance against standard, and compensation. Special investigations. 1 unit. Prerequisite: Industrial Engineering 453. PIGAGE.

458. Laboratory Investigations in Industrial Engineering. Special investigations of such problems as optimization of operations, programming systems, work standards, plant layout, and flow of materials. $\frac{1}{2}$ to $1\frac{1}{2}$ units. STAFF.

473. Ergonomics Seminar. Same as Physiology 473. Topics in ergonomics are explored in depth, such as effects of vibration on human performance, biomechanics of the hand, and functional dimension. $\frac{1}{2}$ unit. Prerequisite: Industrial Engineering 305 or consent of instructor.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

305. Principles of Ergonomics. Same as Physiology 305. Concepts and design criteria to achieve optimum mutual adjustment of man and his work. Topics such as static and dynamic forces on the human frame, response to environmental stress (heat, vibration, noise), vigilance and fatigue, and man-machine systems are considered. 1 unit. Prerequisite: Consent of instructor. HERTIG.

306. Quantitative Methods in Ergonomics. Same as Physiology 306. Laboratory problems and discussion on measurements of the physical and mental capacities and limitations of human beings in relationship to the stresses and demands of working environment. Students become familiar with techniques and tools such as assessment of human energy expenditures on an industrial job, use of seating research chair; high speed and time lapse photography. Student teams select about six problems from a list of topics, or they may develop problems of special interest to the team. 1 unit. Prerequisite: Physiology or Industrial Engineering 305.

332. Standard Time Systems. The study of development, uses, and limitations of standard time data and predetermined time system. $\frac{3}{4}$ or 1 unit. Prerequisite: Industrial Engineering 232. PIGAGE.

333. Engineering Applications of Statistics. Applications of statistics to engineering problems; the calculated risk in making decisions on observed data; treatment of means, percentage, and variability; control charts, acceptance sampling, linear regressions, correlation, elementary experimental design. Use of desk calculators. $\frac{3}{4}$ or 1 unit. Prerequisite: Mathematics 263 or 363. HENRY.

334. Introduction to Reliability Engineering. Same as General Engineering 334. An introduction to concepts in engineering design, testing, and management for highly reli-

able components and systems. ¾ or 1 unit. Prerequisite: Industrial Engineering 333, or Mathematics 361, or equivalent with consent of instructor. HENRY.

350. Manufacturing Process and Tool Design. A study of and exercises in the design of manufacturing processes and tools for maximum efficiency; the utilization of computer techniques in design of manufacturing processes and tools. ¾ or 1 unit. Prerequisite: Industrial Engineering 282 or a course in engineering economy. DOYLE.

355. Numerical Control of Manufacturing Processes. A study of numerical control systems, manufacturing processes, principles and practices basic to numerical control, and programming methodology for numerical control. ¾ or 1 unit. Prerequisite: Mechanical Engineering 185 or consent of instructor; background in computer technology. DOYLE.

357. Safety Engineering. The study of engineering principles applied to industrial accident prevention; safe plant layout, safety in maintenance, boilers and pressure vessels, design and application of machine guards, material handling and storage, hand and power tools, welding hazards, electrical hazards, flammable liquids and fire protection, industrial health engineering and toxic materials. ¾ or 1 unit. Prerequisite: Consent of instructor. HARPER.

358. Problems in Safety Engineering. Extended and intensified study of specific safety problems; study of industrial safety procedures and methods of application. Designed to provide sound knowledge of accident prevention principles and applications for the student interested in entering the field of safety engineering in industry. ¾ or 1 unit. Prerequisite: Industrial Engineering 357; consent of instructor. HARPER.

359. Industrial Fire Protection. Technical study of fire protection based on engineering analysis; fire losses in industry, occupancy fire hazards, methods of fire prevention, fire detection equipment, control of fire, water supplies and extinguishment methods, hazardous materials, industrial fire brigades, and public fire departments. ¾ or 1 unit. Prerequisite: Credit or registration in Industrial Engineering 357 or consent of instructor. HARPER.

382. Design of Manufacturing Processing Systems. Optimization in selection and arrangement of components of manufacturing process systems to produce parts to design specifications at lowest cost; system simulation and optimization with particular reference to computer utilization and recognition of risk and uncertainty. ¾ or 1 unit. Prerequisite: Mechanical Engineering 185 and 234; Computer Science 101.

386. Industrial Engineering Analysis. Analysis and development of analytical techniques for the solution of problems in industrial engineering; application of statistical methods to uncertainty problems; analysis of linear programming techniques appropriate to the solution of allocation problems dealing with materials, money, men, and machines; queueing theories applied to maintenance and inventories. ¾ or 1 unit. Prerequisite: Mathematics 263, Industrial Engineering 286, or consent of instructor. DESSOUKY, WALLHAUS.

METALLURGY AND MINING ENGINEERING

(Including Petroleum Engineering)

The Department of Metallurgy and Mining Engineering offers graduate work leading to the Master of Science and Doctor of Philosophy. The prerequisite for graduate work in metallurgical or mining engineering is the equivalent of the undergraduate courses in either of these majors which are required for the Bachelor of Science at the University of Illinois. For these major fields a Bachelor of Science in some related field may also be acceptable.

Those wishing to specialize in petroleum engineering or in the more general area of petrophysics should have a Bachelor of Science in engineering with advanced courses in mathematics, chemistry, physics, and/or geology.

A candidate for the Master of Science is required to have a minimum of eight units of

graduate work, including a thesis. If a petition to waive the thesis requirement is granted, a minimum of nine units of graduate work is required. A thesis is required of candidates who hold research assistantships.

Students desiring to work for the Doctor of Philosophy are required to pass the departmental qualifying examination. This examination must be taken no later than the end of the first semester after receiving the Master of Science from this department, or not later than the end of the second semester in residence, if the student has a Master of Science from some other department or university.

The minor requirement of the department for the Doctor of Philosophy may be satisfied by taking courses in fields such as ceramics, chemistry, geology, mathematics, theoretical and applied mechanics, nuclear engineering, and physics.

FACULTY

Professors: C. A. Wert (Head of Department), P. A. Beck, H. K. Birnbaum, R. W. Bohl, W. H. Bruckner, A. J. de Witte, E. J. Eckel, G. Ehrlich, D. S. Lieberman, M. Metzger, B. G. Ricketts, H. E. Risser, T. J. Rowland, A. E. Scheidegger, C. M. Wayman.

Associate Professors: C. J. Altstetter, D. Bond, B. L. Eyre (Visiting), J. A. Simon.

Assistant Professors: B. P. Bardes, H. Claus, Mrs. Euline Eilbracht, F. V. Lawrence, Jr., J. Morral.

Mining Engineering

COURSES FOR GRADUATES

401. Advanced Mineral Dressing and Coal Preparation. Advanced theory and practice of mineral dressing and coal preparation processes. 1 unit.

402. Mine Valuation, Taxation, and Mineral Economics. A study of current methods of evaluating mine properties; methods of taxation of mine properties and mineral reserves; and the relation of mineral resources to economics of society. 1 unit.

405. Advanced Mine Ventilation. Study of physics of air, air conditioning for mines, mine ventilation systems, selection of fans for mines, ventilation surveys and instrumentation. 1 unit. Prerequisite: Consent of instructor.

406. Design of Underground Openings. Engineering problems in the design of underground openings; geologic structure and stress analysis in relation to underground openings. 1 unit. Prerequisite: Mining Engineering 356.

414. Physical Chemistry of Clays and Soils. Same as Agronomy and Ceramic Engineering 414. The application of physical chemical principles and concepts to surfaces and adsorption on surfaces. Silicate surfaces and water adsorption are emphasized. Offered in 1970-1971 and in alternate years. 1 unit. Prerequisite: Chemistry 340 and 341, or equivalent, or consent of instructor. R. J. Miller.

497. Special Problems. Individual studies in areas of mining or petroleum engineering, not covered by regular course offerings, carried out under the supervision of a member of the staff. 0 to 2 units. Prerequisite: Consent of instructor.

499. Thesis Research. Individual research in some phase of the general field of mining or petroleum engineering under the supervision of a member of the staff. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Mineral Processing. Crushing, grinding, flotation, proximate analysis of coal, pumping of fluid-solid mixtures, quality control in ore dressing. $\frac{3}{4}$ unit.

302. World Mineral Economics. The role of minerals in a productive economy; the interdependence of minerals in industrial society and the problems arising out of their unequal geographic distribution and divided political control. $\frac{3}{4}$ or 1 unit.

351. Geophysical Prospecting. Same as Geology 351. Principles of geophysics and their application to mining processes. ¾ or 1 unit. Prerequisite: Consent of instructor.

353. Sampling, Exploration, Valuation. Theory of sampling applied to mineral deposits and concentrating plants; geological principles of exploration; surface and subsurface exploration; valuation. ¾ or 1 unit. Prerequisite: Geology 101 and 130; Mathematics 263.

356. Rock Mechanics. Mechanical properties of rocks; design of mine openings in bedded, massive, and fractured rock; methods of support; drilling; blasting. ¾ or 1 unit. Prerequisite: Mining Engineering 351.

360. Analysis and Design of the Mining System. Analyses of unit operation cycles and production methods; design of materials handling systems and applications of operations research. 1 unit. Prerequisite: Mathematics 263; credit or registration in Mining Engineering 356.

393. Special Problems. Individual studies of any phase of mining or petroleum engineering selected by the student and approved by his adviser and the staff member who will supervise the study. 0 to 1 unit. Prerequisite: Consent of instructor.

Metallurgical Engineering

COURSES FOR GRADUATES

406. Advanced Physics of Metals. The free electron theory of metals; the zone theory of metals; magnetism and electrical conductivity. 1 unit. Prerequisite: Metallurgical Engineering 405, or Physics 385, or consent of instructor.

407. Plastic Deformation and Annealing of Metals. The mechanism and crystallography of plastic deformation of single crystals and of polycrystalline metals; annealing effects: recovery, subgrain growth and recrystallization; deformation textures and annealing textures. 1 unit. Prerequisite: Consent of instructor.

408. Dislocations and Mechanical Properties of Metals. General static and dynamic properties of single dislocations in crystals; dislocation interactions; properties of dislocation arrays; role of dislocations in metallurgical phenomena with particular emphasis on mechanical properties. 1 unit. Prerequisite: Consent of instructor.

409. Crystal Physics. The anisotropic properties of crystals treated by tensor and matrix methods with applications to paramagnetism, conduction and diffusion, thermoelectricity, deformation, elasticity, and martensitic transformations. The effects of crystal symmetry and the properties of aggregates are discussed. 1 unit. Prerequisite: Vector algebra, determinants, and thermodynamics; consent of instructor.

410. Advanced X-Ray Metallography. X-ray diffraction as applied to the study of metals and alloys; effects of cold work, annealing, substructures, preferred orientation and ordering, principles of electron and neutron diffraction. 1 unit. Prerequisite: Chemistry 427 or consent of instructor.

420. Metallurgical Thermodynamics. Fundamental thermodynamic considerations and applications of thermodynamics to metallurgical problems; particular emphasis on heterogeneous equilibrium and thermodynamic properties of solutions; topics approached from the viewpoints of both macroscopic thermodynamics and statistical mechanics. 1 unit. Prerequisite: Metallurgical Engineering 314 or equivalent.

421. Kinetics of Phase Changes in Metals. The viewpoint of statistical thermodynamics, rate theory, diffusion in solids, interface energy, nucleation theories, phenomenological analysis of nucleation and growth; application to crystal growth, diffusionless phase changes, oxidation, pearlite reaction, precipitation, sintering. 1 unit. Prerequisite: Metallurgical Engineering 420 or consent of instructor.

430. Surface Physics. Same as Physics 430. Introduction to theory and experiment on

atomic behavior of crystal surfaces; thermodynamics of surfaces; surface energy; diffraction and structure; gas-solid collisions; Brownian motion, diffusion and evaporation; electron and ion emission, tunnelling; Van der Waals forces; theory of chemical interactions; kinetics and statistics of absorption. 1 unit. Prerequisite: Metallurgical Engineering 421 or Physics 489, or consent of instructor.

485. Metallurgical Engineering Problems. Individual study in areas of metallurgical engineering not covered by regular course offerings, carried out under the supervision of a member of the staff. ¼ to 2 units. Prerequisite: Consent of instructor.

486. Laboratory Investigations in Metallurgy. Special investigations in metallurgy to provide an opportunity to employ some advanced experimental methods of research. Available only to non-thesis students enrolled in a Master of Science program. ¼ or ½ unit. Prerequisite: Consent of instructor.

492. Seminar on Surfaces. Discussions and lectures on current research on surfaces and related areas. 0 or ¼ unit. Prerequisite: Consent of instructor.

493. Seminar in Anelasticity. Lectures and discussions of the nature of anelasticity and its application to metallurgy. 0 or ¼ unit. Prerequisite: Consent of instructor.

494. Seminar on Phase Transformations in Metals. Discussion of current research in this field including presentation by graduate students of their own work. 0 or ¼ unit. Prerequisite: Consent of instructor.

495. Seminar on Diffusion and Imperfections. Lectures and discussions on diffusion and imperfections in crystalline solids. 0 or ¼ unit. Prerequisite: Consent of instructor.

497. Seminar on Alloy Phases. Discussion and lectures on current research, including work by the graduate students, relating to the electronic structure and crystal structure of alloy phases. 0 or ¼ unit. Prerequisite: Consent of instructor.

498. Colloquium in Physical Metallurgy. Review of current metallurgical research in other laboratories by visiting lecturers. Some of the research currently done in the department is also reviewed. Required of all graduate students in metallurgical engineering. No credit.

499. Thesis Research. Individual research in specialized problems under the supervision of members of the staff. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Metallurgy of Welding. Heat flow and thermal cycles in welding and cutting of metals; physical metallurgy and mechanical properties of weld metal and thermally altered base metal; joining methods in relation to composition, microstructure, and mechanical properties; specifications, economics, and service requirements. ¾ or 1 unit. Prerequisite: Metallurgical Engineering 208 or equivalent.

302. Powder Metallurgy. Production and testing of powdered metals; fabrication and application of metal shapes produced from powdered metals. ½ or ¾ unit. Prerequisite: Approval of department; registration in Metallurgical Engineering 304.

304. Powder Metallurgy Laboratory. Experiments involving the testing, briquetting, sintering, repressing of metal powders, and the testing of sintered compacts. ¼ unit. Prerequisite: Approval of department; registration in Metallurgical Engineering 302.

306. Design of Engineering Alloys. A study of the fundamental principles which determine the constitution, structure, treatment, and application of alloy steels and other special-purpose high-performance alloys. ¾ or 1 unit. Prerequisite: Metallurgical Engineering 208 and 311.

307. Corrosion of Metals. Electrochemistry, thermodynamics, and kinetics of corrosion; behavior of ferrous and nonferrous metals; corrosion rates; corrosion control, cathodic and anodic protection; high-temperature corrosion; corrosion testing; electrolytic machining methods. ¾ or 1 unit. Prerequisite: Mechanical Engineering 234 or equivalent.

310. X-Ray Metallography. X-ray generation and scattering with applications to problems in physical metallurgy, such as phase identification, the determination of solid solubility, the measurement of grain size and preferred orientation, and other topics. ¾ unit. Prerequisite: Physics 108.

311. Advanced Phase Diagrams. Interpretation of multicomponent phase diagrams for metal systems. ½ unit. Prerequisite: Metallurgical Engineering 201 or equivalent.

314. Metallurgical Thermodynamics. Thermodynamic principles are applied to the study of phase and chemical equilibrium and to the calculation of free energy of phases. ¾ unit. Prerequisite: Credit or registration in Chemistry 246.

315. Metallurgical Kinetics. Diffusion and heat flow calculations and their applications to kinetics of metallurgical processes. ¾ unit. Prerequisite: Metallurgical Engineering 208 and 314.

316. Mechanical Metallurgy. Fundamentals of plastic deformation of crystalline solids; elementary theory of statics and dynamics of dislocations; applications to deformation of single crystals and polycrystals; fracture; effect of metallurgical variables on mechanical properties. ¾ unit. Prerequisite: Consent of instructor.

318. Physics of Metals. The nature of the perfect and imperfect crystal, the electronic structure of solids, electrical conduction in metals and semiconductors, dielectric and magnetic properties of solids. ¾ unit. Prerequisite: Consent of instructor.

334. Physical Metallurgy for Engineers. Fundamentals of crystallography, imperfections, alloying, deformation. Consideration of composition temperature, and prior thermal and mechanical treatment in the use of metals, with emphasis on their mechanical properties. ¾ or 1 unit. Prerequisite: Credit or registration in Theoretical and Applied Mechanics 221 or Aeronautical and Astronautical Engineering 224, or consent of instructor.

384. Properties of Solids. Same as Electrical Engineering 384. Perfect and imperfect crystal lattices, electronic structure of solids including basic theory and applications to transport properties of metals and semiconductors, semiconductor diodes; dielectric and magnetic properties of solids. ¾ unit. Prerequisite: Physics 383.

386. Electron Microscopy and Diffraction Theory. Theory and application of transmission electron microscopy and diffraction with emphasis on thin crystals. Electron optics, interference phenomena, interpretation of images and diffraction patterns, specimen preparation, etc. Students interested in laboratory experience may enroll in Chemistry 429. 1 unit. Prerequisite: Metallurgical Engineering 310 or equivalent.

387. Advanced Physical Metallurgy. Continuation of Metallurgical Engineering 201. Relation of structure to properties of metals; phase transformations; surface reactions; effect of forming processes on properties. Credit not allowed for both this course and Metallurgical Engineering 208 or 251. ¾ unit. Prerequisite: Metallurgical Engineering 201 or 334, or consent of instructor.

388. Advanced Physical Metallurgy Laboratory. Use of physical and mechanical properties and metallography to study metals. To be taken concurrently with Metallurgical Engineering 387. ¾ unit. Prerequisite: Registration in Metallurgical Engineering 387.

Petroleum Engineering

COURSES FOR GRADUATES

420. Porous Media Hydromechanics. Introduction to theoretical hydromechanics. Classification of fluids, fundamental laws and basic equations of motion applicable to microscopic and macroscopic regimes; treatment of interfacial forces and surfaces in multiphase flow as particularly applied to porous media systems. ¾ or 1 unit. Prerequisite: Mathematics 343, Petroleum Engineering 373, or consent of instructor.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

371. Reservoir Mechanics, I. The mechanics of the movement of fluids in the porous rock reservoirs of the subsurface, especially as related to questions dealing with the production and storage of petroleum fluids, ground water, and natural gases. 1 unit. Prerequisite: Mathematics 345; Theoretical and Applied Mechanics 235.

372. Reservoir Mechanics, II. A continuation of Petroleum Engineering 371, showing the application of the fundamental concepts in developing procedures for forecasting the future performance of reservoir systems as derived from a knowledge of initial and boundary conditions, and as derived with reference to the past history of fluid movement and displacement. 1 unit. Prerequisite: Petroleum Engineering 371.

373. Advanced Reservoir Engineering. Physical principles of oil production including the hydrodynamics of the recovery process with attention given to the valuation and practical economic aspects. $^3/_4$ or 1 unit. Prerequisite: Mathematics 345, Petroleum Engineering 372, or consent of instructor.

MICROBIOLOGY

See descriptions and course listings under Life Sciences, page 263.

MUSIC

The School of Music offers the Master of Music, Doctor of Musical Arts, Doctor of Philosophy in Musicology, Master of Science in Music Education, Advanced Certificate in Music Education, and Doctor of Education with a major in Music Education. Inquiries concerning graduate work in music should be addressed to Duane A. Branigan, Director of the School of Music, 100 Smith Music Hall.

Master of Music. The major field may be in musicology, music theory and composition, or performance and literature (organ, voice, piano, violin, viola, cello, solo wind instruments, and percussion instruments).

The admission requirement, in terms of grade-point average, is at least 3.5. In addition, an applicant is required: (1) to have finished successfully a four-year undergraduate curriculum in music or music education, or its equivalent, at the University of Illinois or another accredited institution; and (2) to pass a qualifying examination in the major field of concentration. If the major is to be performance and literature, this examination is essentially one of performance on the major instrument. If an applicant is unable to appear before the graduate committee, recordings may be substituted. If the major is to be musicology, theory, or composition, applicants must present to the committee writings or other evidence of their ability to pursue work on the graduate level. For the field of musicology, a reading knowledge of German or French is required. Candidates in voice should have had one year each of French, German, and Italian, unless two years of one language have been completed in high school. All prospective candidates for the Master of Music must take a placement examination in the history of music and the theory of music.

Doctor of Musical Arts. The fields of specialization for this degree are limited to those areas which can serve properly as a basis for the development of the comprehensive type of musicianship and scholarship the candidate is expected to exhibit. The degree programs comprise the following major areas: composition, choral music, piano, organ, violin, viola, cello, voice, and wind instruments.

In addition to meeting the general requirements for admission to the Graduate College, an applicant must obtain the recommendation of the graduate committee of the School of Music in order to be admitted to this program. The prerequisites for admission are as follows:

(1) The Master of Music with major field in one of the areas listed above, including work as follows (or its equivalent):

(a) Major in Composition: advanced composition, two units; theory, two units; Music 428, Problems and Methods, one unit; electives, three units.

(b) Major in Performance and Literature: performance and literature, two units; special literature, two units; Music 428, Problems and Methods, one unit; electives, three units.

(2) A high level of proficiency in composition or performance.

(3) Appropriate experience in ensemble playing and/or score reading.

(4) The successful completion of approximately thirty-two semester hours (or the demonstration of an equivalent background) in the liberal arts and sciences including a minimum of six hours in each of the following: general history, literature, and philosophy. Students lacking an appropriate background in liberal arts and sciences may be admitted provisionally, providing they satisfy the stated requirements before taking the preliminary examination.

(5) Successful completion of entrance examinations. These examinations in performance and literature, the history of music, and the theory of music must be taken immediately prior to the student's first registration. Prospective applicants should write to the School of Music, 100 Smith Music Hall, for complete information concerning the nature of these examinations.

If the candidate fails to pass the entrance examinations, he must repeat and pass all or parts of them no later than the end of the second semester in residence, or pass deficiency courses with grades of at least B. Until the examinations or courses have been passed, the student is considered to have a provisional status.

After admission to the doctoral program, the student must fulfill all requirements of the Graduate College pertaining to residence, number of units of graduate work, examinations, grades, and major and minor fields. The language examinations may be selected from the following depending upon the thesis topic: German, French, Russian, Italian, Spanish, Portuguese, Arabic, and Japanese. The selection must have the approval of the doctoral committee.

A minimum of sixteen units of graduate credit beyond the eight units required for the Master of Music is necessary to earn the Doctor of Musical Arts. In the fields of composition, and performance and literature, three units are devoted to the completion of a special doctoral project: for the former, the writing of an original score on a large scale; for the latter, the study of a comprehensive repertory and either two solo recitals, or one solo recital and two of the following options: (1) a concerto performance; (2) the performance of a major role in an opera or oratorio; (3) a chamber music program; (4) a lecture-recital; (5) a coaching performance of an instrumental or vocal ensemble. Two units are devoted to the completion of an original thesis. In the field of choral music, one unit is devoted to a doctoral project involving the preparation and presentation of a choral program of approximately one hour in length selected from a comprehensive repertory. Four units are devoted to the completion of an original thesis.

In addition to the above, work for the Doctor of Musical Arts includes the following required courses: composition or performance and literature, three units; Music 420, Seminar in Music Literature, for doctoral candidates, two units. One unit of work must be taken in the field of education or music education unless the candidate has previously passed equivalent course work. At least two, but no more than four units, are normally devoted to an outside minor field. If, however, in the opinion of the graduate adviser, the candidate has acquired a strong background in general education, including history, philosphy, and literature, he may substitute an inside minor in such fields as musicology, ethnomusicology, theory, or composition. Candidates for the Ph.D. in Musicology may substitute ethnomusicology, theory, or composition.

Three of the six units of electives must be in music literature or theory.

Prior to the beginning of the doctoral project and the thesis, the student must complete the preliminary examination, which is administered by a committee appointed by the Dean of the Graduate College.

Doctor of Philosophy in Musicology. The Doctor of Philosophy in Musicology is intended for applicants whose interests lie in research in the history of music, theory of music, psychology of music, ethnomusicology, aesthetics, and the relation of music to social life and thought.

In addition to meeting the general requirements for admission to the Graduate College

(see pages 20 to 24), an applicant must obtain the recommendation of the graduate committee of the School of Music in order to be admitted to this program. Applicants must (1) have completed work equivalent to that required by the School of Music of candidates for the Master of Music with a major in musicology or theory of music; (2) have acquired a background of approximately thirty-two semester hours in the liberal arts and sciences, including general history, philosophy, and literature; (3) be adequately prepared to pursue the doctoral program as determined by examinations administered by the graduate committee of the School of Music.

After admission to the doctoral program in musicology, the student must fulfill all requirements of the Graduate College pertaining to residence, number of units of graduate work, thesis, examinations, calendar, grades, major and minor fields, and foreign languages.

Eight of the sixteen units must be in Music 499 and are devoted to the completion of an original doctoral thesis. Admission to candidacy is recommended only after successful completion of the following:

(1) Sixteen units of graduate credit, or the equivalent, in courses including Music 321, 322, 414, 415, and 423. At least twelve of the sixteen units offered for graduate credit must be in the field of music. No more than two of the sixteen units may be in performance.

(2) In addition to the general foreign language requirements, proficiency in Latin is required. An examination in one or more additional foreign languages may be required when, in the opinion of the graduate committee, such ability is necessary for proper research in the student's field of concentration.

(3) A preliminary examination administered by a committee appointed by the Dean of the Graduate College.

Master of Science in Music Education. Candidates for this degree must earn a minimum of four units in music, two units in education, and two units in electives. The program must include one unit in music history and literature courses; one unit in music theory courses and one unit in music education courses including one-half unit in Foundations and Principles of Music Education, I. Required courses in education are Educational Psychology 311 and 312, one unit; and two courses selected from History and Philosophy of Education 301, 302, 303, 304, and 305, one unit. Electives may be in music, education, or another subject approved by the adviser. The grade-point average required for admission is 3.5. All applicants for admission are required to satisfy placement examinations in music history, music theory, and performance and literature in the principal music area. See pages 36 and 37.

Advanced Certificate in Music Education. The program leading to the Advanced Certificate in Music Education consists of a minimum of one year of work beyond the master's degree. The program is designed to provide advanced professional preparation for music educators. It is a terminal program and students who become candidates for the certificate are not considered as beginning work leading to the Doctor of Education with a major in music education.

Admission. A candidate for admission must hold a master's degree in music or music education from an accredited institution and must have completed satisfactorily at least two years of professional employment in music education.

At the first registration, placement examinations are administered in music history, music theory, and applied music.

Residence. At least four units must be earned in residence on the Urbana campus. This requirement may be met by spending one full semester or two eight-week summer sessions in residence.

Program. A minimum of eight units beyond the master's degree is required. Music 440 and 441 and either Educational Psychology 411 or 412 are required. The remainder of the program is based upon the student's needs and interest and upon the deficiencies revealed in placement tests. No more than one unit of performance and literature may be counted toward the certificate.

Students who, at the time of first registration, do not hold a valid teaching certificate in music from the state in which they are employed are required to take courses sufficient to meet the certification requirements.

Doctor of Education. The program leading to the Doctor of Education with a major in Music Education is designed to provide advanced professional preparation for music educators and to develop educational leaders with a high level of musical, professional, and intellectual competence. The program is offered jointly by the School of Music and the College of Education.

Admission. A candidate for admission must hold a master's degree with a major in music education or the equivalent from an accredited institution. Admission is determined by examinations administered by the School of Music and the College of Education, personal interviews, record of previous education and experience, and recommendation from persons who have known the candidate. Examinations are administered by the School of Music in music education, music theory, music history, and applied music.

Applicants for admission should present credentials well in advance of their first registration. Admission is not complete until the candidate is accepted by two joint advisers, one from the School of Music and one from the College of Education.

Residence. Minimum residence requirements are two consecutive semesters during each of which a minimum of three units of work is successfully completed, or one semester during which a minimum of three units is successfully completed and the summer session immediately preceding or following during which a minimum of one and one-half units is successfully completed, plus an additional summer session during which a minimum of one and one-half units is successfully completed.

Program. At least sixteen units of work beyond the master's degree are required, including six units in music courses and six units in education courses. No more than two units of credit in applied music may be counted toward the degree.

The following courses are required: History and Philosophy of Education 410, Educational Psychology 415, Music 421, 440, and 441. The remainder of the program is planned for each candidate in terms of present and future professional needs and interests. For work completed elsewhere, see page 31. Extramural course work may not be included as part of this sixteen-unit requirement.

A thesis is required. It may be in the area of improving professional practice and may be a field study. No academic credit is granted for the thesis. General regulations of the Graduate College covering the filing of thesis title and the preparation, submission, and publication of theses must be met.

FACULTY

Professors: D. A. Branigan (Director of School of Music), J. L. Bailey, B. Bergethon, E. S. Berry, G. W. Binkerd, Dorothy E. Clark, H. A. Decker, C. DeLaney, P. S. Farrell, S. Fletcher, L. T. Fredrickson, J. C. Garvey, S. Goldthwaite, B. M. Goodman, R. E. Gray, R. J. Hamilton, C. E. Hamm, M. H. Hindsley, G. H. Hunter, B. Johnston, H. Karp, J. R. Kelly, Colleen J. Kirk, E. D. Kisinger, E. J. Krolick, C. Leonhard, A. J. McDowell, J. H. McKenzie, B. Nettl, P. S. Pettinga, Claire L. Richards, A. L. Ringer, P. Rolland, D. W. Sanders, H. C. Schmitt, H. O. Sexton, S. Stravinsky, R. H. Swenson, R. E. Thomas, Grace E. Wilson, L. E. Zirner.

Associate Professors: Mary M. Burdette, A. M. Carter, W. R. Coggins, R. J. Colwell, T. L. Holden, R. B. MacDonald, S. Martirano, W. H. Miller, P. Painter, R. B. Smith, N. M. Temperley.

Assistant Professors: G. H. Behague, H. Brün, E. L. Dalheim, D. L. Kohut, M. E. Powell, Evelyn Reynolds.

COURSES FOR GRADUATES

400. Advanced Instrumentation: Chamber and Symphonic. Orchestrate for chamber and symphony orchestras; works of classical, romantic, and modern composers. $\frac{1}{2}$ or 1 unit. Prerequisite: Undergraduate instrumentation. Kelly.

401. Advanced Instrumentation: Band. Arrange for the concert band, works from orchestra, organ, and chamber music by composers of the classical, romantic, and modern periods. $\frac{1}{2}$ or 1 unit. Prerequisite: Undergraduate instrumentation. Hindsley.

402. Analysis in Relation to Performance and Interpretation, I. A unifying course in the structure of music, in which analysis is related to the performance and understanding of music. Course material drawn from standard literature from the Renaissance to the present day with emphasis on the smaller forms. 1 unit. Prerequisite: Music 104 or equivalent; consent of instructor. LEONHARD.

403. Analysis in Relation to Performance and Interpretation, II. A unifying course in the structure of music, in which analysis is related to the performance and understanding of music. Course material drawn from standard literature from the Renaissance to the present day with emphasis on the larger forms. 1 unit. Prerequisite: Music 402. LEONHARD.

406. Composition. Advanced study of contrapuntal forms; study of contemporary melodic and harmonic practices; original work in advanced composition. ½ to 1½ units. COMPOSITION FACULTY.

410. History of Music Theory. 1 unit; maximum accumulated credit, 2 units. Prerequisite: Graduate standing in musicology or composition, or consent of instructor. HAMM.

411. Introduction to Ethnomusicology. A comprehensive survey of concepts, problems, and methods of research in non-Western and folk music. 1 unit. Prerequisite: Graduate standing in musicology or consent of instructor. NETTL.

412. History of Musical Aesthetics, I. A survey of the principal philosphies of music, their historical backgrounds, and their relation to musical styles. From Pythagoreanism to the humanistic period. Offered in 1971-1972 and in alternate years. ½ or 1 unit. Prerequisite: Graduate standing in music. RINGER.

413. History of Musical Aesthetics, II. A survey of the principal philosophies of music, their historical backgrounds, and their relation to musical styles from the seventeenth century to the present day. Offered in 1971-1972 and in alternate years. ½ or 1 unit. Prerequisite: Music 412. RINGER.

414. Notation, I. The history of notation from its beginning to 1400. ½ unit. Prerequisite: Consent of instructor. HAMM.

415. Notation, II. The history of notation from 1400 to 1600, including instrumental tablatures. ½ unit. Prerequisite: Music 414 or consent of instructor. HAMM.

416. History of Instrumental Music to 1600. A study of instrumental music from its beginnings in the Middle Ages to the end of the Renaissance. Offered in 1971-1972 and in alternate years. ½ or 1 unit. Prerequisite: Music 312 or consent of instructor.

417. History of Instumental Music from 1600 to 1750. A study of instrumental music in the Baroque era. Offered in 1971-1972 and in alternate years. ½ or 1 unit. Prerequisite: Music 416 or consent of instructor. FRUM.

418. The Origins and the History of Opera up to Gluck. The antecedents of opera in the sixteenth century; social, cultural, intellectual forces leading to its development; study of scores, librettos, scenography; readings on performance practices, theory, and aesthetics of opera. The principal composers covered are Monteverdi, Cavilli, Cesti, Lully, Rameau, Blow, Purcell, Scarlatti, Handel, Gluck. ½ or 1 unit. Prerequisite: Music 312 or consent of instructor. TEMPERLEY.

419. The History of Opera from Mozart to the Present. A detailed examination of stylistic and structural developments in opera after Gluck, with special reference to representative works from Mozart to Schoenberg viewed in relation to the general musical and cultural background of their time and place of origin. ½ or 1 unit. Prerequisite: Music 312 and 313, or consent of instructor. TEMPERLEY.

420. Seminar to Music Literature. Intensive study of outstanding works selected from all fields of music literature. Required of all students (except those in choral music) enrolled in the Doctor of Musical Arts program. 1 unit; maximum accumulated credit, 2 units. Prerequisite: Consent of instructor. GODT.

421. Seminar in Music Education. An introduction to problems and methods of research

in music education. Required of all candidates for the Doctor of Education in music education. 1 unit. Prerequisite: Graduate standing in music education or consent of instructor. BERGETHON.

422. Seminar in Theory of Music. Intensive study of selected topics in the fields of music theory, history of theory, and history of musical materials. ½ or 1 unit. Prerequisite: Graduate standing in music theory or consent of instructor. LONDON.

423. Seminar in Musicology. Problems in historical and systematic musicology; discussions of special problems and reports on individual research. 1 unit. Prerequisite: Graduate standing in musicology and Music 321, or consent of instructor. STAFF.

424. Seminar in the Works of a Selected Composer. A seminar devoted to intensive historical and analytical study of the works of important composers. Each semester is devoted to one composer, e.g., Bach, Beethoven, Handel, Haydn, Mozart, Wagner, etc. 1 unit; S, ½ unit; may be repeated for a maximum of 2 units. Prerequisite: Music 213 and 214; two of the following: Music 310, 311, 312, 313, 315, or equivalent. STAFF.

428. Problems and Methods. An introduction to methods in research and stylistic criticism and to bibliographic aids, editions and editing of music, as related to the work of the musician and composer. Reports of bibliographic problems and on individual projects are presented orally and in writing. Required of all students in the Master of Music program, except those majoring in musicology. 1 unit. BEHAGUE, TEMPERLEY.

429. Historical Studies in Twentieth-Century Music. A seminar in contemporary music, with emphasis on the historical foundations of current trends in musical composition. ½ to 1 unit; maximum accumulated credit, 2 units. Prerequisite: Music 315, 422, or equivalent. RINGER.

430. Advanced Orchestra Conducting and Literature. Intensive study of conducting techniques and problems related to standard orchestral literature. Includes a survey of materials for school and community orchestra. 1 unit. Prerequisite: Previous conducting experience. GOODMAN.

431. Advanced Band Conducting and Literature. Study of problems and techniques of band conducting and a survey of literature for the concert band. 1 unit. Prerequisite: Bachelor's degree with major work or experience in band and/or orchestra; consent of instructor. HINDSLEY.

432. Advanced Choral Techniques. An intensive laboratory approach to the development of advanced techniques necessary for working effectively with choral ensembles. 1 unit. Prerequisite: Graduate standing in music. KIRK.

433. Advanced Choral Literature and Conducting. An intensive survey of choral literature with laboratory organization for reading, conducting, and interpretation of choral music of all periods, styles, and voice arrangements. 1 unit. Prerequisite: Graduate standing in music education, Music 432 or equivalent, or consent of instructor. DECKER, KIRK.

434. Piano Literature. 1 unit; maximum accumulated credit, 2 units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education, or consent of instructor. STRAVINSKY.

435. Vocal Literature. Study of solo song in larger works, and solo art song. 1 unit; maximum accumulated credit, 2 units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education, or consent of instructor. DALHEIM.

436. Organ Literature. An intensive study of organ literature from Bach to the present. The material includes the music itself, recordings, and collateral readings. 1 unit; maximum accumulated credit, 2 units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education, or consent of instructor. PETTINGA.

437. String Instrument Literature. 1 unit; maximum accumulated credit, 2 units. Prerequisite: Bachelor of Music or Bachelor of Science in Music Education, or consent of instructor. FARRELL.

438. Wind Instrument Literature. An integrating course offering the opportunity to survey at the graduate level the field of solo and ensemble wind literature. The material includes analysis and performance, when possible, of the music itself, recordings, and collateral readings. 1 unit; maximum accumulated credit, 2 units. KISINGER, WIND FACULTY.

439. Percussion Instruments Literature. An integrating course offering the opportunity to survey and analyze the field of solo and ensemble percussion literature. The material includes analysis and performance, when possible, of the music itself, recordings, and collateral readings. 1 unit; maximum accumulated credit, 2 units. Prerequisite: Graduate standing in music; consent of instructor. MCKENZIE.

440. Foundations and Principles of Music Education, I. A consideration of the historical and philosophical foundations of music education; the application of the principles of education to the music program. Major emphasis is placed on current trends in educational thought and their implications for music education. ½ or 1 unit. Prerequisite: Graduate standing in music education; consent of instructor. LEONHARD.

441. Foundations and Principles of Music Education, II. A consideration of the psychological foundations of music education; the application of the principles of education to the music program. Major emphasis is placed on current trends in educational thought and their implications for instruction, supervision, administration, and evaluation in music education. ½ or 1 unit. Prerequisite: Graduate standing in music education; consent of instructor. LEONHARD.

442. The General Music Program in Secondary Schools. A detailed consideration of the general music program, its objectives, organization, and operation. Special attention is given to materials and methods of teaching. ½ or 1 unit. Prerequisite: Graduate standing in music education. LEONHARD.

443. Administration and Supervision of Music Education. Deals with the functions of supervisors and directors of music education in administering music programs in elementary and secondary schools. ½ or 1 unit. Prerequisite: Graduate standing in music or music education. BERGETHON.

444. The General Music Program in Elementary Schools. A detailed consideration of elementary general music, its objectives, organization, operation. Special attention is given to materials and methods of teaching. ½ unit. Prerequisite: Graduate standing in music education. BERGETHON.

445. Music in Higher Education. An orientation to the organization, teaching, and administration of music in the college and university. ½ or 1 unit. Prerequisite: Graduate standing in music or music education. BERGETHON.

446. Seminar in Experimental Music, I. Survey of contemporary electronic music, computer music and related types of music. Discussion of relevant music theory. ½ unit. Prerequisite: Music 303 or consent of instructor. BRÜN.

447. Seminar in Experimental Music, II. Continuation of Music 446. ½ unit. Prerequisite: Music 446 or consent of instructor. BRÜN.

450. History of Vocal Ensemble and Choral Music, I. A critical and analytic study of vocal and choral ensemble music from the Middle Ages to 1750. 1 unit; S, ½ unit. GODT.

451. History of Vocal Ensemble and Choral Music, II. A critical and analytic study of vocal and choral ensemble music from 1750 to the present. 1 unit; S, ½ unit. GODT.

480. Piano. ½ or 1 unit. Prerequisite: Bachelor of Music; successful completion of a qualifying examination given by the graduate committee. GRADUATE FACULTY.

481. Voice. ½ or 1 unit. Prerequisite: Bachelor of Music; successful completion of a qualifying examination given by the graduate committee. GRADUATE FACULTY.

482. Organ. Selected studies from the masterworks of organ literature. ½ or 1 unit. Prerequisite: Bachelor of Music; successful completion of a qualifying examination given by the graduate committee. GRADUATE FACULTY.

483. String Instruments. ½ or 1 unit. Prerequisite: Bachelor of Music; successful completion of a qualifying examination given by the graduate committee. GRADUATE FACULTY.

484. Wind Instruments. ½ or 1 unit. Prerequisite: Bachelor of Music; successful completion of a qualifying examination given by the graduate committee. GRADUATE FACULTY.

485. Percussion Instruments. ½ or 1 unit. Prerequisite: Bachelor of Music; successful completion of a qualifying examination given by the graduate committee. GRADUATE FACULTY.

489. Doctoral Projects. Special projects for candidates for the Doctor of Musical Arts. Open only to students in the Doctor of Musical Arts program. 1 to 3 units. Prerequisite: Consent of instructor. GRADUATE FACULTY.

499. Thesis Research. Research in special projects. 0 to 4 units. Prerequisite: Consent of instructor. GRADUATE FACULTY.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Eighteenth-Century Counterpoint. The study of the technique of contrapuntal writing as found in the works of J. S. Bach and other eighteenth-century composers. Imitation, canon, invertible counterpoint, two- and three-part inventions, etc., are studied through writing and analysis of compositions by eighteenth-century composers. ½ unit. Prerequisite: Music 104 and/or consent of instructor. BINKERD, FREDRICKSON, HUNTER, JOHNSTON, KELLY.

301. Fugue. The study of fugal writing during the eighteenth and early nineteenth centuries. A continuation of the study of tonal counterpoint begun in Music 300, with special emphasis on the study and analysis of the fugal works of J. S. Bach, Handel, and Beethoven and on the writing of fugues and part fugues. ½ unit. Prerequisite: Music 300 and/or consent of instructor. BINKERD, FREDRICKSON, HUNTER, JOHNSTON, KELLY.

302. Musical Acoustics, I. A survey of basic topics in the physics of music: wave motion and the physical properties of sound; the ear and hearing; timbre, formant theory, and the acoustical properties of musical instruments. ½ unit. Prerequisite: Consent of instructor. BEAUCHAMP.

303. Musical Acoustics, II. Acoustics, mathematics, aesthetics of pitch organization in music; scales, tuning, and temperament; pitch and rhythm, and their structural interrelationships; theories of perception of pitch and rhythm. ½ unit. Prerequisite: Music 302 and/or consent of instructor. BEAUCHAMP.

304. Contemporary Compositional Techniques. Studies in specialized areas of composition for advanced undergraduates and graduates majoring in composition-theory. May be elected by others with consent of instructor. ½ unit. Prerequisite: Music 104, 106, 109, or consent of instructor. COMPOSITION FACULTY.

306. Composition. Work in original composition including the small and large homophonic forms. ½ or 1 unit. Prerequisite: Music 104 or 106, or consent of instructor. COMPOSITION FACULTY.

307. Counterpoint of the Fifteenth and Sixteenth Centuries. Analysis and writing in the principal contrapuntal styles of the fifteenth and sixteenth centuries. ½ unit. Prerequisite: Consent of instructor. BINKERD.

308. Analysis of Musical Form. An intensive study of representative compositions of the sixteenth through the twentieth centuries for structure and form. ½ unit. Prerequisite: Music 104 and 109, or consent of instructor. FARRELL, JOHNSTON.

310. Ancient and Medieval Music. A history of music from its origins to about 1400. ½ unit. Prerequisite: Music 131 or 214, or consent of instructor. I. THOMAS.

311. Music in the Renaissance. A history of music from about 1400 to 1600. ½ unit. Prerequisite: Music 131 or 214, or consent of instructor. WARD.

312. Music of the Seventeenth Century. A history of music from about 1600 to 1700. ½ unit. Prerequisite: Music 131 or 214, or consent of instructor. FRUM.

313. Music of the Eighteenth Century. A history of music from about 1700 to 1800. ½ unit. Prerequisite: Music 131 or 214, or consent of instructor. FRUM.

314. Music of the Nineteenth Century. A history of music from about 1800 to 1900. ½ unit. Prerequisite: Music 131 or 214, or consent of instructor. TEMPERLEY.

315. Music of the Twentieth Century. A history of music from about 1900 to the present. ½ unit. Prerequisite: Music 131 or 214, or consent of instructor. HAMM.

316. Introduction to Music of the World's Cultures. Same as Anthropology 316. An introduction to non-Western and folk music, to the role of music in the world's societies, and to the methods of collecting and studying music in non-literate, folk, and Asian high cultures. For students outside the School of Music. ½ unit. Prerequisite: Anthropology 103 or consent of instructor. NETTL.

317. Area Studies in Ethnomusicology. Same as Anthropology 315. A seminar devoted to intensive study in the music of one specific culture, e.g., (a) Japan, (b) China, (c) Indonesia, (d) India, (e) the Near East, (f) African and New World Negro, (g) European and American folk cultures, (h) American Indian. ½ unit; maximum accumulated credit, 2 units. Prerequisite: Senior standing in music or consent of instructor. BEHAGUE, NETTL.

318. History of Performance Practices, I. The study of musical performance from about 900 to 1600. Discussion of musical instruments, makeup of instrumental and vocal ensembles, etc., are supplemented by demonstration performances of selected works using the University's collection of instruments. ½ unit. Prerequisite: Senior standing in music theory and music history or consent of instructor. HUNTER.

319. History of Performance Practices, II. The study of musical performance from 1600 to 1750. Discussion of musical instruments, ornamentation, basso continuo, etc., are supplemented by demonstration performances using the University's collection of instruments. ½ unit. Prerequisite: Senior standing in music theory and music history or consent of instructor. HUNTER.

320. Proseminar. Provides special preparation in specialized fields of musicology, music education, theory, and composition. ½ or 1 unit; maximum accumulated credit, 2 units. Prerequisite: Senior or graduate standing in music or music education; consent of instructor. GRADUATE FACULTY.

321. Proseminar in Musicology. A practical introduction to research in musicology, devoted each time to intensive study of a selected topic, including the use of primary source materials, lectures, and reports. 1 unit; maximum accumulated credit, 2 units. Prerequisite: Graduate standing in musicology or consent of instructor. I. THOMAS, WARD.

322. Introduction to Musicology. A survey of the various fields open to musicological research, both systematic and historical, with bibliographical studies and elementary problems for investigation. ½ or 1 unit; maximum accumulated credit, 2 units. Prerequisite: Senior or graduate standing in music, or consent of instructor. HAMM.

323. Opera Production, I. Designed to help interested students on the graduate level to study the problems of the lyric stage. Casting methods, program selection, production procedures, stage direction, coaching methods, and opera dramatics are investigated and practiced. ½ unit. Prerequisite: Music 265 and 381; consent of instructor. ZIRNER.

324. Opera Production, II. Designed to help interested students on the graduate level to study the problems of the lyric stage. Casting methods, program selection, production procedures, stage direction, coaching methods, and opera dramatics are investigated and practiced. ½ unit. Prerequisite: Music 323. ZIRNER.

329. History of Musical Instruments. The evolution of instruments, both Western and non-Western, considered in their social and cultural settings; construction and playing

techniques of instruments treated in relation to performance practice and stylistic developments. ½ unit. Prerequisite: Music 213 and 214, or consent of instructor. NETTL.

330. Applied Music Pedagogy. A survey of techniques, practices, and materials; presentation of group and individual instruction; an approach to teaching problems, tone production, musical styles and interpretation for various age levels. Actual teaching experience under faculty supervision. Required of applied music majors in piano and string instruments. ½ unit; maximum accumulated credit, 1 unit. Prerequisite: Consent of instructor. BURDETTE, LYKE, MILLER, ROLLAND.

332. Church Music Literature. A survey of the development of church music with emphasis on the period since 1500. Offered in 1971-1972 and in alternate years. ½ unit. Prerequisite: Music 214 or 311, or consent of instructor. HAMILTON.

333. Church Music Techniques. The technical problems of the church musician: chanting, liturgical practices, organization, repertoire. ½ unit. Prerequisite: Music 332 or consent of instructor. HAMILTON.

334. The Music of America, I. A study of folk, popular, and art music in America from the time of the first European settlers through the middle of the nineteenth century; psalmody, early opera and concert life, African and European folk music, the singing school, music of European immigrants, and the roots of jazz. ½ unit. Prerequisite: Senior standing in music or consent of instructor. BEHAGUE.

335. The Music of America, II. A study of chamber, choral, and orchestral music written by American composers from 1850 to the present; jazz and its offshoots; folk and popular music, and experimental music in America. ½ unit. Prerequisite: Senior standing in music or consent of instructor. BEHAGUE.

336. Music in Latin America. Studies in the history of music in Latin America from colonial times to the present, including its cultural and social background. Each semester is devoted to a specific area, e.g., Caribbean America and Venezuela, Colombia and the Andean nations, Brazil and the River Plate nations. A reading knowledge of Spanish or Portuguese is recommended. ½ or 1 unit; maximum accumulated credit, 2 units. Prerequisite: Consent of instructor. BEHAGUE.

340. Instrumental Clinic and Band Pageantry. A study of the pecularities of the individual instruments, criteria for selection, and accepted teaching methods and procedures for each instrument. Band pageantry deals with formation designing, charting and show continuity, marching fundamentals, and special problems. ½ unit. Prerequisite: Advanced undergraduate or graduate standing, with major work or experience in band or orchestra. KISINGER.

341. Advanced Instrumental Administration. Administration of bands and orchestras in public schools and colleges. 1 unit. Prerequisite: Advanced undergraduate or graduate standing, with major work or experience in band or orchestra. KISINGER.

342. Percussion Methods. Designed primarily for teachers of school music who may or may not be percussion performers, but who wish to teach percussion and initiate such a program in the schools. ½ unit. Prerequisite: Senior or graduate standing in music education; Music 174 and 257, or equivalent. SIWE.

343. Tests and Measurement in Music Education. Construction, design, appraisal, and use of measurement devices for music teaching and research. ½ or 1 unit. Prerequisite: Consent of instructor. COLWELL.

344. Methods of String Class Teaching. Designed primarily for teachers of school music who are not performers on a string instrument, yet would like to be able to teach string classes and start an orchestral program in the schools. S; ½ unit. Prerequisite: Senior or graduate standing in music education or consent of instructor. D. MILLER.

345. Teaching Techniques of Music Theory. Teaching materials, methods, texts, and pedagogical sequence are discussed and analyzed, including an intensive survey of the structural materials normally covered during the first two years of collegiate study. ½ unit. Prerequisite: Music 300 or consent of instructor. CARTER.

346. Workshop in Music Education. Workshop designed to develop essential facts, attitudes, and principles through a consideration of problems encountered in music education. Parallel with this study is the preparation of resource materials for music programs in elementary and secondary schools. S; ½ or 1 unit; maximum accumulated credit, 2 units. Prerequisite: Senior or graduate standing in music education or consent of instructor. BERGETHON, LEONHARD, R. E. THOMAS.

347. Teaching of Woodwind Instruments. Designed primarily for teachers of instrumental music in the public schools. S; ½ unit. Offered in 1970 and in alternate years. Prerequisite: Senior or graduate standing in music education or consent of instructor. MCDOWELL, WOODWIND FACULTY.

348. Teaching of Brass Instruments. Designed primarily for teachers of instrumental music in the public schools. S; ½ unit. Offered in 1971 and in alternate years. Prerequisite: Senior or graduate standing in music education or consent of instructor. SEXTON, BRASS FACULTY.

349. Music in Early Childhood. Same as Home Economics 349. A detailed consideration of the music program in nursery schools, kindergarten, and the primary grades. Topics covered include the nature of early musical responses, objectives, and experience levels of the program, methods of teaching, and materials. Observation of music teaching in the Child Development Laboratory is included in the course work. ½ unit. Prerequisite: Senior or graduate standing in music education or child development. SMITH.

350. Advanced Ensemble Music. Selected projects in the study and performance of ensemble literature including the areas of operatic, instrumental, and vocal-choral literature and accompanying. ½ unit; S; ¼ unit. Prerequisite: Registration in applied music at the 300 level; consent of instructor. GARVEY, HUNTER, SWENSON, ZIRNER.

Applied Music

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

Private instruction on the advanced undergraduate and graduate level. Prerequisite: Completion of comparable course at the 100 level; qualifying examination for transfer students.

377. Class Piano (Advanced). An integrated course in piano instruction with emphasis placed upon the acquisition of keyboard knowledge and skills essential for effective school music teaching; includes work in harmonization, transposition, improvisation, and vocal and instrumental score reduction. ½ unit. Prerequisite: Music 104, 109, 180, or consent of instructor. LYKE.

380. Piano. ½ or 1 unit; S, ¼ or ½ unit. BAKER, FLETCHER, HEILES, KARP, RAFOLS, RICHARDS, SANDERS, STRAVINSKY.

381. Voice. ½ or 1 unit; S, ¼ or ½ unit. BAILEY, BURDETTE, CLARK, CRAWFORD, ELYN, FOOTE, MILLER, REYNOLDS, G. WILSON.

382. Organ. ½ or 1 unit; S, ¼ or ½ unit. HAMILTON, PETTINGA.

383. Violin. ½ or 1 unit; S, ¼ or ½ unit. FARMER, ROLLAND, SCHMITT.

384. Viola. ½ or 1 unit; S, ¼ or ½. GARVEY.

385. Cello. ½ or 1 unit; S, ¼ or ½ unit. FARRELL, SWENSON.

386. String Bass. ½ or 1 unit; S, ¼ or ½ unit. KROLICK.

387. Flute. ½ or 1 unit; S, ¼ or ½ unit. DELANEY.

388. Clarinet. ½ or 1 unit; S, ¼ or ½ unit. COGGINS, MCDOWELL.

389. Oboe. ½ or 1 unit; S, ¼ or ½ unit. EDLEFSEN.

390. Bassoon. ½ or 1 unit; S, ¼ or ½ unit. BERRY.

391. Cornet and Trumpet. ½ or 1 unit; S, ¼ or ½ unit. SEXTON.

392. French Horn. ½ or 1 unit; S, ¼ or ½ unit. HOLDEN.

393. Trombone. ½ or 1 unit; S, ¼ or ½ unit. GRAY.

394. Baritone. ½ or 1 unit; S, ¼ or ½ unit. PERANTONI.

395. Tuba. ½ or 1 unit; S, ¼ or ½ unit. PERANTONI.

396. Percussion. ½ or 1 unit; S, ¼ or ½ unit. SIWE.

397. Harp. ½ or 1 unit; S, ¼ or ½ unit. ROSENFIELD.

398. Saxophone. ½ or 1 unit; S, ¼ or ½ unit. COGGINS.

399. Harpsichord. ½ or 1 unit; S, ¼ or ½ unit. HUNTER.

NUCLEAR ENGINEERING

Nuclear engineering offers work leading to the Master of Science and Doctor of Philosophy and provides courses and research facilities for doctoral candidates in nuclear engineering and related fields.

The programs in nuclear engineering are open to all graduates in engineering, mathematics, and the physical sciences who have a grade-point average of at least 4.0 out of 5.0 for the last two years of undergraduate work. Students with grade-point averages below 4.0 but above 3.5 are considered individually. Applicants who fall in this latter category are invited to support their applications with a letter explaining the circumstances. It is recommended that they also submit letters of reference and information as to their rank in class.

Undergraduate courses in differential equations, advanced calculus, and atomic physics are required as background for the nuclear engineering program. A student may be admitted before he has completed these three prerequisites, but he must then allow an additional semester or summer of study for completion of the master's degree.

The general requirements of the Graduate College must be met for either degree. A candidate for the M.S. degree who does not submit a thesis must complete nine units of graduate work.

The Illinois Advanced TRIGA reactor is located on campus for research and teaching in nuclear engineering and operates at a steady state power of 1.5 megawatts. The reactor can be pulsed to power levels of 5,000 megawatts for special studies. Teaching facilities include a nuclear metallurgy laboratory, a radiochemistry and nuclear instrumentation laboratory, a boiling water heat transfer loop, several subcritical natural uranium assemblies, a waste disposal laboratory, a shielding laboratory, and a direct energy conversion laboratory.

For further information, see the brochure *Graduate Program in Nuclear Engineering*, available from the Nuclear Engineering Office, 214 Nuclear Engineering Laboratory.

FACULTY

Professors: M. E. WYMAN (Chairman of Nuclear Engineering Program), F. T. ADLER, A. W. ALLEN, R. A. AXFORD, R. W. BOHL, A. P. BORESI, B. T. CHAO, A. B. CHILTON, G. A. COSTELLO, B. B. EWING, O. L. GADDY, L. GOLDSTEIN, D. F. HANG, C. D. HENDRICKS, J. P. HUMMEL, J. S. KOEHLER, H. H. KORST, R. J. MARTIN, M. S. MCVAY, G. H. MILEY, J. E. PEARSON, S. L. SOO, J. T. VERDEYEN.

Associate Professors: B. E. CHERRINGTON, B. G. JONES.

Assistant Professors: H. MERKELO, N. H. SCHILMOELLER, B. W. WEHRING.

COURSES FOR GRADUATES

401. Fundamentals of Nuclear Engineering. A lecture and problem course to provide background for further work in nuclear engineering. Problems in materials, heat transfer, and fluid flow. Special emphasis is given to basic ideas and the mathematical similarity of problems in heat transfer, fluid flow, and neutron diffusion. 1 unit. Prerequisite:

Credit or registration in Nuclear Engineering 397 or Physics 382, or equivalent; credit in Mathematics 345 or equivalent.

411. Nuclear Reactor Heat Transfer. Selected topics in nuclear reactor heat transfer: thermal analysis of fuel elements under steady and transient operation, convective energy transport from reactor cores, two-phase flow and boiling in reactor cores, and liquid metal coolant systems. 1 unit. Prerequisite: Nuclear Engineering 401 or consent of instructor.

421. Nuclear Concepts. Selected topics in low-energy nuclear physics of general interest to the nuclear engineering fields; nuclear reactions, cross sections, slowing down and interactions with matter, decay theory, and nuclear forces. 1 unit. Prerequisite: Credit in a nuclear physics course such as Nuclear Engineering 397 or Physics 382.

431. Nuclear Metallurgy. Metallurgical principles applied to materials problems in nuclear engineering, including topics in production of uranium, corrosion, radiation damage, fuel element fabrication, and fuel reprocessing. 1 unit. Prerequisite: Consent of instructor.

441. Nuclear Radiation Shielding. Radiation units and measurement; tolerance limits; interaction of radiation and matter; geometry factors in attenuation; gamma ray and neutron attenuation; moment theory for attenuation; application to reactors, protective shelters, and space vehicles. 1 unit. Prerequisite: Nuclear Engineering 349; credit or registration in Nuclear Engineering 455; consent of instructor.

447. Radioactive Waste Disposal. Same as Civil Engineering 447. Sources and characteristics of radioactive wastes; methods of treatment; ultimate disposal; fate of radioisotopes in the environment; permissible levels in air and water; current levels in water supplies; water treatment methods; monitoring techniques; solid waste disposal; gaseous waste disposal; air monitoring; and reactor site selection and hazards evaluation. $\frac{1}{2}$ or 1 unit. Prerequisite: Physics 282 or Chemistry or Nuclear Engineering 398, or consent of instructor.

451. Reactor Laboratory. Reactor operation: start-up, changes in power level, and shutdown. Reactor instrumentation: subcritical assemblies; flux measurements in core and thermal column; control rod worth measurements; effects of changes in fuel configurations; activation and neutron beam experiments. $\frac{1}{2}$ or 1 unit. Prerequisite: Nuclear Engineering 347 or consent of instructor.

454. Nuclear Engineering Laboratory Investigations. Individual laboratory investigations in nuclear engineering. $\frac{1}{4}$ to 2 units. Prerequisite: Consent of instructor.

455. Reactor Physics, I. Same as Physics 455. An introduction to the physical concepts of reactor analysis; nuclear cross sections; diffusion, slowing down, and thermalization of neutrons; homogeneous reactor theory; introduction to heterogeneous reactor theory and reactor kinetics; computer applications in reactor analysis. 1 unit. Prerequisite: Mathematics 343 and 345, Nuclear Engineering 347, or consent of instructor.

456. Reactor Physics, II. Same as Physics 456. Neutron transport theory; current methods of solution of the transport equation; fast and thermal neutron spectra; applications in heterogeneous reactor analysis and other areas of reactor physics; digital computer methods. 1 unit. Prerequisite: Nuclear Engineering 455 or consent of instructor.

458. Nuclear Reactor Engineering. Development of engineering design phases of the fission chain reactor: reactor materials and radiations, thermal aspects, heat removal, radiation hazards, shielding, reactor performance, controls and instrumentation, types and applications, fuel conversion, reactor power economics. 1 unit. Prerequisite: Nuclear Engineering 347 or consent of instructor.

460. Reactor Kinetics. Discussion of special topics such as response of reactor systems to changes of power demand and reactivity. Transfer function analysis, nonlinear problems of reactor dynamics, reactor stability; fuel cycles; digital and analog computer methods for solving reactor kinetic problems. 1 unit. Prerequisite: Nuclear Engineering 401; credit or registration in Nuclear Engineering 455; consent of instructor.

467. Thermomechanics of Nuclear Reactor Systems. Same as Theoretical and Applied Mechanics 467. Origin of thermomechanics problems in nuclear reactor systems; heat generation and transfer in nuclear power systems; thermal stress in nuclear reactor systems; dynamical theory including effects of thermal shock and thermal stress-wave propagation; current thermomechanics problems in nuclear reactor design. Term paper required. 1 unit. Prerequisite: Nuclear Engineering 401 or consent of instructor.

490. Special Topics. Selected areas are considered which are of current interest in research, such as nuclear materials, advanced reactor systems, thermonuclear problems, digital computer methods in nuclear engineering, advanced topics in reactor theory. $^1/_2$ or 1 unit. Prerequisite: Consent of instructor.

495. Nuclear Engineering Problems. Individual study in areas of nuclear engineering and closely related fields not covered by regular course offerings. The work is carried out under the supervision of a member of the staff. $^1/_4$ to 2 units. Prerequisite: At least three units of graduate work; consent of instructor.

497. Seminar in Nuclear Science and Engineering. Lectures and discussions on current work in research and development in nuclear engineering and related fields by staff, advanced students, and visiting lecturers. No credit.

499. Thesis Research. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

302. Nuclear Power Engineering. Same as Mechanical Engineering 302. Principles of release and utilization of fission energy in nuclear power engineering, including such topics as: fission processes and controlled chain reactions; nuclear reactor types, design principles and operational characteristics; power reactor design criteria; radiation hazards and radioactive waste treatment; economics; and other applications such as propulsion and research reactors. 1 unit. Prerequisite: Consent of instructor.

347. Introduction to Nuclear Engineering. Nuclear particles and nuclear chain reactions, energy release from fission; classification of nuclear reactors; fast and thermal reactors; reactor theory; slowing down and diffusion of neutrons; radiation shielding; materials of construction, radiation damage; reactor instrumentation, safety, and control; chemical processing of nuclear materials. 1 unit. Prerequisite: Credit or registration in Nuclear Engineering 397 or Physics 382, or equivalent.

349. Fundamentals of Radiation Protection. Same as Civil Engineering 349. Principles and practice of health physics and radiation protection engineering, including such topics as: principles of dosimetry, sources of ionizing radiation; determination of radiation tolerances; dosimetric instruments; standards and regulations. $^3/_4$ or 1 unit. Prerequisite: Credit or registration in Nuclear Engineering 397 or Physics 382, or equivalent.

397. Radiochemistry. Same as Chemistry 397. Properties of radioactive nuclei, nature of radioactivity, nuclear structure, nuclear reactions, interactions of radiations with matter, chemical aspects of radioactivity work, and applications of nucleonics to chemistry. $^3/_4$ unit. Prerequisite: One semester of physical chemistry, or one semester of atomic physics, or consent of instructor.

398. Radiochemistry Laboratory. Same as Chemistry 398. Radioactivity detection and tracer applications of radioisotopes in chemistry and other fields. One laboratory and one discussion period per week. $^1/_2$ unit. Prerequisite: One semester of physical chemistry, or one semester of atomic physics, or consent of instructor.

NUTRITIONAL SCIENCES

A graduate training program leading to the Master of Science and Doctor of Philosophy in Nutritional Sciences is offered under the auspices of an interdepartmental Committee on Nutritional Sciences. The degree requirements are designed to provide the basic knowledge

of those disciplines (such as biochemistry, physiology, and microbiology) which is necessary for conducting fruitful research in the broad field of the nutritional sciences, along with advanced training in an area of specialization. Emphasis in thesis research is placed on the study of metabolic processes pertaining to the nutrition of microorganisms, animals, and man. Through cooperative arrangements with the appropriate departments, thesis research also may be conducted on the socio-economic aspects of human nutrition.

In addition to the general requirements for admission to the Graduate College, applicants are required to have a minimum grade-point average of 4.0 computed on the basis of the University grading system for the last sixty hours of undergraduate work. They are expected to have sound basic courses in chemistry, biology, and mathematics. Applicants who are deficient in one or more of these subjects are required to remove such deficiencies during their first year of graduate study.

Financial assistance is available in the form of assistantships, fellowships, and traineeships.

Inquiries should be directed to the Nutritional Sciences Program, 437 Bevier Hall.

FACULTY

Professors: R. E. Brown, C. L. Davis, H. H. Draper, R. M. Forbes, F. A. Kummerow, G. A. Leveille, S. P. Mistry.
Associate Professor: Betty E. Haskell.
Assistant Professor: D. H. Baker.

COURSES FOR GRADUATES

400. Nutritional Sciences Seminar. Discussions on current problems in nutritional sciences. Required of all graduate students in the nutritional sciences program. ¼ unit. Staff.

Additional courses offered in this program are described under departmental listings: Animal Science 420, Comparative Nutrition; Animal Science 421, Topics in Nutritional Biochemistry; Dairy Science or Animal Science 481, Animal Biochemical Laboratory Techniques; Food Science or Home Economics 324, Problems in Nutrition.

PHILOSOPHY

The normal program of graduate study for philosophy majors is directed toward the Doctor of Philosophy. A limited number of students who wish to work for the Master of Arts alone are admitted. Graduate students majoring in other fields who wish to offer philosophy as a minor, or to include philosophy in their programs in a less formal way, are encouraged to consult with members of the graduate faculty in philosophy in order to plan appropriate courses of study.

Entrance Requirements.

Grade-Point Average. The normal requirement for admission is an average of 4.0 in the last sixty semester hours of work (or its equivalent). In special cases applicants are admitted with averages lower than 4.0, but in no case where the average is less than 3.75.

Preparatory Work. Each student should have had (1) a course in elementary logic, (2) a course in the theory of knowledge, (3) a course in ethics, and (4) a general course in the history of philosophy (the main figures of ancient and modern philosophy). Students with deficiencies in this regard are required to fill them by taking (1) Philosophy 102, (2) Philosophy 330 or 331, (3) Philosophy 321, or (4) Philosophy 303 and/or Philosophy 306, depending upon the student's particular deficiencies. Courses taken to fill such deficiencies may not be used to satisfy course requirements in the graduate program. No graduate credit is given for Philosophy 102, and a grade of A or B must be obtained.

Letters of Recommendation. All applications for admission only (as well as applications for admission and financial aid) must be supported by three letters of recommendation. The

letters should be in each case from persons qualified to speak of the candidate's apitutude for graduate study in philosophy. Candidates are asked to have these letters transmitted directly to the Committee on Admissions and Financial Aid of the Department of Philosophy.

Graduate Record Examinations. All applicants for admission are likewise required to take the General Aptitude portion of the Graduate Record Examination and to have their scores transmitted to the department.

Master of Arts. Each student who has passed his preliminary examination for the Ph.D. is automatically qualified by the department to receive the A.M.

This degree may also be earned by completing one full year of residence study in philosophy at the University of Illinois (including six of the eight units required for the degree), submitting a substantial essay, and passing an oral examination on the essay given by a committee appointed by the Chairman of the Department. A degree earned in this way is normally a terminal one.

Doctor of Philosophy. In the preliminary examination, required of all candidates for this degree, each student is required to demonstrate a basic competence in the following four broad areas of philosophy: (1) history of philosophy, (2) theory of knowledge, (3) metaphysics, and (4) ethics and value theory.

Candidates for this degree are not generally required to offer work in a minor field outside the department. However, where a student's advanced study in philosophy would be strengthened by the inclusion of work in a related field, he may be advised to include such work in the courses taken to satisfy the requirements for the degree. The amount of such work is limited to two units, unless the student wishes the work to count as an extra-departmental minor. Then the minimum work accepted is two units, the maximum four.

Prior to taking the preliminary examination each candidate is required to demonstrate a basic competence in mathematical logic. This may be done by passing an approved course in the subject or passing a proficiency examination administered by the department.

Subsequent to the preliminary examination the student must submit an acceptable dissertation in one of the above four areas of philosophical research and pass a final examination on the dissertation. The acceptability of the dissertation is judged, and the final examination administered, by the student's doctoral committee.

A more detailed description of the graduate program in philosophy may be secured from the Department of Philosophy, 105 Gregory Hall.

FACULTY

Professors: J. D. Wallace (Chairman of Department), C. E. Caton, B. J. Diggs, D. S. Shwayder, H. M. Tiebout, A. R. Turquette, F. L. Will.

Associate Professors: H. S. Chandler, R. C. Stalnaker.

Assistant Professors: R. N. Faber, P. G. Hugly, F. W. Neely, T. J. Nickles, R. L. Schacht, F. R. Suppe.

COURSES FOR GRADUATES

401. Seminar in Ancient Philosophy. 1 unit. May be repeated for credit.

403. Seminar in Medieval Philosophy. 1 unit. May be repeated for credit.

405. Seventeenth-Century Continental Thought (Descartes, Spinoza, Leibniz). A study of the basic philosophical works of the three leading continental thinkers of the century. 1 unit. May be repeated for credit.

407. British Empiricism. 1 unit. May be repeated for credit.

408. Seminar in Kant. 1 unit. May be repeated for credit. Hugly, Neely.

409. Recent American Philosophy. Major American philosophers and movements since about 1900. Reports and discussions. 1 unit. May be repeated for credit.

410. Seminar in Nineteenth-Century Philosophy. 1 unit. May be repeated for credit. Schacht.

411. Seminar in Recent Ethical Theory. 1 unit. May be repeated for credit.

412. Seminar in Social Philosophy. A seminar designed to study special problems in social philosophy. Particular attention is given to the contributions of the social sciences to social philosophy. To be offered with varying topics. 1 unit. May be repeated for credit. DIGGS.

413. Logical Theory. 1 unit. Prerequisite: A course in logic or consent of instructor. May be repeated for credit. TURQUETTE.

415. Seminar in Metaphysics. Intensive study of a selected topic of major importance in the field of metaphysics. 1 unit. May be repeated for credit. SHWAYDER.

417. Seminar in the Philosophy of Science. Various problems arising from specific studies in philosophy pertaining to science and vice versa. To be offered with varying topics. 1 unit. May be repeated for credit. NICKLES, STALNAKER, SUPPE.

420. Seminar in Semantics. Same as Communications 420. Intensive study of important contemporary contributions in the fields of semantics, analytic philosophy, and the philosophy of language. 1 unit. May be repeated for credit. FABER.

421. Seminar in Contemporary Problems. Intensive study of selected problems or topics in contemporary philosophy, with particular emphasis on questions of knowledge and value. 1 unit. May be repeated for credit.

423. Seminar in the Theory of Knowledge. Selected topics and writings of major importance in the contemporary philosophy of knowledge. 1 unit. May be repeated for credit. WILL.

425. Seminar in the Philosophy of Mind. Selected topics from major writings in the philosophy of mind. 1 unit. May be repeated for credit. NEELY, WALLACE.

430. Seminar in Modern Aesthetics. 1 unit. May be repeated for credit.

439. Seminar in the Philosophy of Mathematics. Detailed examination of important questions arising from philosophical and logical analyses of mathematics. 1 unit. May be repeated for credit. Prerequisite: Consent of instructor. SUPPE.

453. Individual Topics. Individual study and oral written reports on topics not covered in other courses. Not more than one unit may be counted toward the A.M. degree and not more than two toward the Ph.D. degree. Topics and plan of study must be approved by the candidate's adviser and by the staff member who directs the work. $\frac{1}{2}$ to 2 units. STAFF.

499. Thesis Research. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. History of Greek and Roman Philosophy. 1 unit.

304. History of Medieval Philosophy. Lectures and reading in the history of philosophy from St. Augustine to William of Ockham. $\frac{3}{4}$ or 1 unit. Prerequisite: Philosophy 101 or 303. WENGERT.

306. History of Modern Philosophy. 1 unit. NEELY, SCHACHT.

307. History of Modern Philosophy. Bacon, Hobbes, Locke, Berkeley, Hume. Philosophy 307 and 308 taken concurrently in the summer session are the equivalent of Philosophy 306. S; $\frac{1}{2}$ unit. Prerequisite: Consent of instructor.

308. History of Modern Philosophy. Descartes, Spinoza, Leibniz, Kant. Philosophy 307 and 308 taken concurrently in the summer session are the equivalent of Philosophy 306. S; $\frac{1}{2}$ unit. Prerequisite: Consent of instructor.

309. The Philosophy of Plato. $\frac{3}{4}$ or 1 unit. Prerequisite: Philosophy 101 or 303.

310. The Philosophy of Aristotle. An intensive study of major works of Aristotle or of some aspects of his philosophy. 1 unit. Prerequisite: Philosophy 101 or 303.

311. Philosophic Ideas of the Nineteenth Century. $\frac{3}{4}$ or 1 unit. Prerequisite: One course in philosophy (preferably Philosophy 101 or 306). SCHACHT.

312. The Philosophy of Kant. An intensive study of the major works of Kant, and in particular, of the *Critique of Pure Reason*. ¾ or 1 unit. Prerequisite: One course in philosophy. HUGLY, NEELY.

313. American Philosophy. The history of philosophy in America from colonial times to the present. ¾ or 1 unit. Prerequisite: One course in philosophy.

315. European Philosophy Since 1900. An introduction to the major recent philosophical movements in Europe, such as phenomenology, existentialism, philosophical anthropology, and neo-Marxism. 1 unit.

316. Anglo-American Philosophy Since 1900. An introduction to the major philosophical developments in England and America in the present century, focusing on such writers as G. E. Moore, Bertrand Russell, A. J. Ayer, Ludwig Wittgenstein, and W. V. Quine. 1 unit. Prerequisite: One course in philosophy.

317. Great Books in Modern Thought. Reading and discussion of selected books which either have produced or themselves reflect in some important way a changed conception of man and the world. ¾ or 1 unit. Prerequisite: One course in philosophy.

321. Ethics and Value Theory. ¾ or 1 unit. Prerequisite: One course in philosophy. CHANDLER, NEELY, WALLACE.

322. Recent Developments in Ethics. Ethical theories of the last fifty years; intuitionism, naturalism, pragmatism, emotivism, existentialism, analytic ethics. ¾ or 1 unit. Prerequisite: Philosophy 103, 105, or 321. NEELEY, WALLACE.

323. Philosophy of Art. ¾ or 1 unit. SCHACHT.

324. Philosophy of Religion. ¾ or 1 unit. Prerequisite: One course in philosophy. CHANDLER.

325. Philosophy of Mind. Philosophical problems arising in connection with mental phenomena; the relation of mind and body; free will and determinism; our knowledge of other minds; the self and personal identity. ¾ or 1 unit. Prerequisite: One course in philosophy. NEELY.

326. Metaphysics. ¾ or 1 unit. Prerequisite: One course in philosophy. CHANDLER, SHWAYDER.

327. Philosophy of Science: Advanced Survey. A comprehensive survey of the literature on the main problems in the philosophy of science, with an emphasis on the physical sciences. Topics include: nature of theories; laws and counterfactuals; inductive logic and confirmation theory; models; experimental methodology; explanation; development of theories; concept formation. 1 unit. Prerequisite: Philosophy 107 or consent of instructor. NICKLES, STALNAKER, SUPPE.

328. Philosophy of Science. A study of some philosophical problems that have developed from modern science. ¾ or 1 unit. Prerequisite: One course in philosophy. TURQUETTE.

329. The Philosophy of Social Science. A survey of philosophical problems encountered in the disciplines concerned with man and society, with particular emphasis on the extent to which questions and subject matter in these fields are amenable to scientific treatment. 1 unit. STALNAKER.

330. Theory of Knowledge. The relative acceptability of authority, intuition, and the method of hypothesis as ways of establishing belief; logical and empirical truth; pragmatism and positivism; other selected contemporary topics. ¾ or 1 unit. Prerequisite: One course in philosophy. CATON, WILL.

331. Analytic Philosophy. Advanced treatment of problems of knowledge and method and introduction to contemporary techniques of philosophical analysis. Meaning and verification; inductive and deductive method; perceptual knowledge; certainty; other selected topics. ¾ or 1 unit. Prerequisite: One course in philosophy. CATON, HUGLY, SHWAYDER.

332. Perception and Knowledge. A systematic study of basic problems in the philosophy of

perception: perceiving as a mental state; the objects of perception; sensing, sensation, and sense-data; perception and the external world; perception as the basis of empirical knowledge. Traditional empiricist philosophies of perception are examined and contemporary criticisms and defenses are assessed. 3/4 or 1 unit. Prerequisite: One course in philosophy.

333. Symbolic Logic. A study of the elementary principles of symbolic analysis as applied to logical problems. 3/4 or 1 unit. TURQUETTE.

334. Symbolic Logic. A general study of the more refined methods of symbolic analysis as applied to logical problems. Particular attention is devoted to proof procedures as they relate to the question of consistency and completeness. 3/4 or 1 unit. Prerequisite: Philosophy 333. TURQUETTE.

335. Social Philosophy. Selected topics from: the nature of social organization, nature and convention, utility, justice, equality, liberty, rights, and duties. 3/4 or 1 unit. Prerequisite: Philosophy 103, or 321, or consent of instructor. DIGGS, WERNER.

336. Philosophy of Law and of the State. 3/4 or 1 unit. Prerequisite: One course in philosophy. DIGGS, WERNER.

337. Semantics. An investigation of semantical concepts such as denoting and truth; study of the functions of language, definition, meaning and verification, semantical paradoxes. 3/4 or 1 unit. Prerequisite: A course in logic. FABER.

338. Philosophies of Language. Same as Linguistics 338. A study of the development of philosophical problems about language and the treatment of them from antiquity through the nineteenth century. 3/4 or 1 unit. Prerequisite: One course in philosophy. FABER.

339. Philosophy of Mathematics. Introduction to some of the main philosophical problems and contemporary viewpoints concerning mathematical concepts, mathematical methods, and the nature of mathematical truths. The concept of infinity; conventionalism and formalism; the distinction between analytic and synthetic truths; necessity; mathematics and the problem of universals; other related topics. 3/4 or 1 unit. Prerequisite: One course in philosophy.

340. The Philosophy of Alfred North Whitehead. An examination of the mature thought of A. N. Whitehead, primarily as contained in *Process and Reality* and *Adventures of Ideas*, taking into account both the cosmological scheme and the application of his technical philosophy to social philosophy, to ethics, and to philosophy of religion. 3/4 or 1 unit. Prerequisite: One course in philosophy. TIEBOUT.

341. Existential Philosophy. A study of a selection of the major writings of the more important existential philosophers, e.g., Heidegger, Jaspers, Sartre. 3/4 unit. Prerequisite: One course in philosophy (preferably Philosophy 311) or consent of instructor. SCHACHT, TIEBOUT.

343. Phenomenology. A study of the development of phenomenology from Husserl to the present. 3/4 or 1 unit. Prerequisite: One course in philosophy. SCHACHT.

350. Philosophy and Modern Life. A study of the relation between philosophy and contemporary life, including an analysis and discussion of the philosophical principles involved in the artistic, intellectual, cultural, and social developments of the modern world. 3/4 or 1 unit. Prerequisite: One course in philosophy.

353. Metamathematics, I. Formal mathematical systems and their semantics: sentential, first-order predicate calculus, predicate calculus with identity; formal semantics and model theory of these systems, consistency and completeness theorems; Gödel completeness theorem. Löwenheim-Skolem theorem, compactness theorem. Intended primarily for philosophy majors. 1 unit. Prerequisite: Philosophy 102, or graduate standing, or consent of instructor. SUPPE.

354. Metamathematics, II. A continuation of Philosophy 353. Elementary arithmetics; Craig's theorem and Beth definability results; arithematization, recursive enumerabil-

ity, recursive functions; Church's thesis; Church's theorem; Gödel incompleteness theorems and their extensions; Tarski's truth theorem; alternative approaches to recursive function theory; selected additional topics. Intended primarily for philosophy majors. 1 unit. Prerequisite: Philosophy 353 in the previous semester, or consent of instructor. SUPPE.

355. Inductive Logic. Philosophical foundations of probability theory—formal development and applications of the frequency, logical, and subjective interpretations to the philosophical problems of induction and confirmation. 1 unit. Prerequisite: Philosophy 333 or 353, or Mathematics 410, or consent of instructor. STALNAKER.

361. Comparative Religions: The Religions of the East. A comparative philosophical analysis of the philosophic doctrines and the mythologies of Hinduism, Buddhism, and Taoism, with incidental reference to Jainism, Sikhism, Confucianism, and Shinto. 3/4 or 1 unit. Prerequisite: One course in philosophy. TIEBOUT.

362. Comparative Religions: The Religions of the West. A comparative philosophical analysis of the philosophic doctrines and religious symbols of Judaism, Christianity, and Islam. 3/4 or 1 unit. Prerequisite: One course in philosophy. TIEBOUT.

363. Contemporary Religious Thought. An analysis of contemporary philosophical developments in Judaism, Christianity, and Islam, with particular emphasis upon "Neo-orthodox" Protestant thought. 3/4 or 1 unit. Prerequisite: One course in philosophy. TIEBOUT.

PHYSICAL EDUCATION

The department offers graduate programs leading to the Master of Science emphasizing increased scholarly research competence, the Master of Science in the Teaching of Physical Education, emphasizing increased teaching competence, and the Doctor of Philosophy, emphasizing advanced scholarly research in one of three closely related areas, namely: physical education, health and safety education, or recreation and park administration.

Master of Science. The admission requirements for a major are: (1) a minimum grade-point average of 4.0 (B) for the last sixty semester hours of undergraduate study (applicants whose averages are below 4.0 but above 3.75 are considered on an individual basis); (2) thirty semester hours of approved undergraduate credit in physical education, including a course in tests and measurements; (3) eighteen semester hours of undergraduate credit in science; (4) sixteen semester hours of undergraduate credit in education; (5) acceptable scores on the Miller Analogies Test and on the aptitude part of the Graduate Record Examination; and (7) approval of the Graduate College.

Candidates for this degree must complete eight units including: (1) four units in physical education, including Physical Education 495; (2) two approved units in another discipline directed toward a specific research interest; (3) Physical Education 490, one semester, no credit; and (4) thesis, two units.

Master of Science in the Teaching of Physical Education. TheMaster of Science in the Teaching of Physical Education is primarily an advanced program for increasing teaching proficiency. (See Table of Contents for information relative to the requirements for Teacher Certification.) The admission requirements are identical with those for the Master of Science in Physical Education.

Candidates for this degree must complete eight units including: (1) four units in physical education or approved related courses, including Physical Education 495; (2) two units in education, including Educational Psychology 311 and 312 and two of the following: History and Philosophy of Education 301, 302, 303, and 304; (3) Physical Education 490, one semester, no credit; and (4) thesis, two units. The thesis requirement may be waived upon approval of a petition, but the student must substitute two additional units of course work and pass a comprehensive examination.

Doctor of Philosophy. This program permits specialization in one of three related

areas: physical education, health and safety education, or recreation and park administration.

The admission requirements for each major area are: (1) those outlined for admission to the program for the master's degree; (2) completion of work for the master's degree with a high level of achievement; (3) approval of the head of the department concerned (contingent upon interviews, various test scores, written recommendations, etc.); and (4) approval of the Graduate College.

Candidates for this degree must complete a minimum of twenty-four units of credit, including the following: (1) a minimum of eight units in the major or related fields (physical education, health education, or recreation); (2) one minor for a minimum of four units, or two minors for a minimum of two units each (in both cases outside the major and related fields); (3) ability to translate accurately two foreign languages, or ability to read, write, and converse satisfactorily in one foreign language, or two additional approved graduate course units may be substituted for each of the two foreign languages; (4) a seminar, 490, in the major field; and (5) completion of an acceptable dissertation.

FACULTY

Professors: R. G. Wright (Head of Department), Alyce T. Cheska, T. K. Cureton, Jr., A. W. Hubbard, Laura J. Huelster, B. H. Massey, D. O. Matthews, K. J. McCristal, R. H. Pohndorf, R. E. Shelton, E. F. Zeigler.

Associate Professors: Joanna Davenport, Phyllis Hill, W. Johnson, R. Keller, G. Lüschen, A. C. Moore, Marjorie Souder, Olive G. Young, Evelyn Schurr, Marianna Trekell, J. E. Razor.

Assistant Professors: B. D. Franks, Annelis Hoyman, Nell C. Jackson, D. Landers, T. Lohman, B. H. Williams.

COURSES FOR GRADUATES

401. Administration of Physical Education and Sport. Analysis of completed research relating to theory and practice of administration in physical education and sport; the development of policy statements and procedures manuals for the various educational levels; experience in the use of the case plan of instruction as a teaching technique for the development of competence and knowledge relating to human relations and administration in this specialized field. 1 unit. Prerequisite: Physical Education for Men or Physical Education for Women 204 or equivalent. Huelster, Matthews, Wright, Zeigler.

402. History of Physical Education and Sport. An analysis of the research literature related to the historical foundations of physical education and sport; discussion of such persistent historical problems as the influence of economics, politics and nationalism, curriculum and methods of instruction, professional preparation, the healthy body, dance, the use of leisure, and amateur and professional sport. 1 unit. Prerequisite: Physical Education for Men or Physical Education for Women 209 or equivalent. Trekell, Zeigler.

406. Philosophy of Physical Education and Sport. Philosophical analysis of physical education and sport (with some reference to school health and recreation) in the light of the leading philosophical tendencies and possible implications for public and private education; analysis of completed research; includes delineation of one's personal philosophy and the use of philosophical analysis as a research technique. 1 unit. Prerequisite: Philosophy 101; History and Philosophy of Education 305. Huelster, Zeigler.

407. Sport Psychology. Analysis of psychological factors and principles with special reference to motor performance, learning motor skills, perception and emotion in sports situations; review of literature; independent projects. 1 unit. Prerequisite: Psychology 100; Educational Psychology 211; consent of instructor. Hubbard, Young.

408. Principles of Kinesiotherapy. Analysis of medically approved techniques employed in the treatment of disease and injury by exercise and movement; kinesiological evaluation of principles involved; therapy preparation in teaching techniques; medically

prescribed clinical training; literature; research. 1 unit. Prerequisite: Anatomy, physiology, kinesiology, and physiology of exercise, or consent of instructor. Shelton.

416. Experimental Kinesiology. Mechanical and neuromuscular approach to human movement, analysis, experimental research findings, lecture and laboratory discussions. 1 unit. Prerequisite: Physiology 234 or equivalent; Physical Education for Men or Physical Education for Women 206 or equivalent; or consent of instructor. Huelster.

451. Scientific Foundations of Physical Fitness. Scientific basis for physical fitness; analysis of fitness programs and fitness tests; techniques in remedial clinics; literature; research. Includes laboratory session. 1 unit. Prerequisite: Undergraduate anatomy and physiology, tests and measurements. Massey.

452. Scientific Analysis of Physical Education Activities. Analysis of selected activities in terms of physiological, anatomical, physical mechanics, and kinesiological features, involving both cinematographical and metabolic methods. Includes laboratory session. 1 unit. Prerequisite: Anatomy, physiology, kinesiology, elementary physics, algebra, and trigonometry, or consent of instructor. Massey.

453. Anthropometrical and Body Mechanics Research Techniques. Critical analysis of the techniques of anthropometrical and body mechanics measurements; analysis of selected research studies; laboratory and computational projects in biophysical study. 1 unit. Prerequisite: College algebra and trigonometry; Physical Education 495 and 451. Massey.

490. Seminar. Lectures, discussions, and critiques on physical education and related subjects by faculty members and visiting professional leaders; presentation and criticism of student theses. No credit. Staff.

493. Special Projects. Independent research on special projects. Offered summers as special group practicums. $\frac{1}{2}$ or 1 unit. Staff, Visiting Faculty.

495. Techniques of Research in Health, Physical Education, and Recreation. Review and appraisal of common research procedures; application of statistical procedures, library methods, evaluation procedures, and experimental methods. 1 unit. Hubbard, Pohndorf, Trekell.

499. Thesis Research. Preparation of theses in physical education. 0 to 4 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

302. Problems of Facilities Planning, Construction, and Utilization. Physical education facilities as related to objectives of physical education; consultant services with planning committees and architects; cost factors in different types of construction; the use of standards as a check on and guide for planning; safety factors; changes in playing surfaces due to research; building and field maintenance problems. $\frac{1}{2}$ or 1 unit. Prerequisite: Physical Education for Men or Physical Education for Women 204 or equivalent, or consent of instructor. Keller.

303. International Physical Education and Sport. A study of objectives, methods, personnel, facilities, and evaluation of selected national programs of physical education. Additional consideration is given to sports clubs, indigenous games, and research. $\frac{1}{2}$ or 1 unit. Prerequisite: Physical Education for Men or Physical Education for Women 209, or consent of instructor. Johnson.

307. Motor Learning. Discussion and analysis of scientific principles related to the learning and performance of motor skills; review of related literature and research in motor learning. 1 unit. Prerequisite: Physical Education for Men or Physical Education for Women 206, Physiology 234, Psychology 100, Educational Psychology 211, or equivalents of these courses, or consent of instructor. Souder, Young.

350. Theory and Practice of Exercise Therapy. Theory and practice of therapeutic exercise as it applies to physical rehabilitation of the physically handicapped; physiological and kinesiological principles of physical restoration; the physical educator's

role as related to ancillary medical forces; problems and principles related to kinesiotherapy, preventive, adapted, and remedial physical education and athletic training. 1 unit. Prerequisite: Anatomy, physiology, physiology of exercise, and kinesiology; or consent of instructor. SHELTON.

PHYSICAL SCIENCES

A special program leading to the Master of Science in the Physical Sciences is available to meet the needs of secondary school teachers who wish to get a broad view of the physical sciences rather than to specialize in one department. Since the program is designed primarily for those preparing to teach the physical sciences, chemistry and physics are emphasized. Students working toward degrees under the provisions of this program are expected to seek approximately equal proficiency in both physics and chemistry; those whose undergraduate work has emphasized chemistry should balance this by weighting the graduate work in favor of physics, and vice versa. No thesis is required, and all courses in physics, chemistry, geology, astronomy, and mathematics which normally give graduate credit are acceptable toward the degree. To qualify for the degree, a student must present at least one course in mathematics beyond calculus, for which calculus is prerequisite. In addition, he must have met the requirements for teacher certification.

Candidates for the Master of Science in the Teaching of the Physical Sciences, which is distinct from the program described above, must earn four units in the physical sciences, two units in education, and two units in electives. The two units in education must include the following courses: History and Philosophy of Education 304 and 305, one unit; and Educational Psychology 311 and 312, one unit. The courses in the physical sciences and the electives—which must normally give graduate credit—must be selected with the approval of the adviser. The electives may be in the physical sciences, in education, or, in exceptional cases, in other fields. Students applying for admission must have a grade-point average of at least 3.5. See pages 36 and 37.

Inquiries concerning these programs should be directed to Professor D. H. Secrest, 155 Noyes Laboratory.

PHYSICS

The Department of Physics offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy in Physics.

There is opportunity for specialization in atomic and nuclear physics, including research in elementary particle physics; in nuclear magnetic resonance; in theoretical physics; in the physics of solids, including research on ionic crystals, metals, semiconductors, cryogenics, and surface physics; in plasma physics and aeronomy.

Requirements for admission to the Graduate College with a major in physics are twenty semester hours of physics, including Physics 321, 341, and 342, or the equivalent, and excluding courses in general physics, and an average of at least 3.75 for the last sixty hours of undergraduate work. Advanced undergraduate courses in light, thermodynamics, and atomic and quantum physics are strongly recommended.

The requirements for the Master of Science in Physics are the general requirements of the Graduate College. They may be satisfied by adequate performance in graduate courses, without the submission of a thesis.

Departmental requirements for the Doctor of Philosophy in Physics, in addition to the general requirements of the Graduate College, are described in a pamphlet which may be obtained from the office of the head of the department.

Candidates for the Master of Science in the Teaching of Physics must earn four units in physics; two units in approved electives; Educational Psychology 311, 312, and one additional unit in education selected from History and Philosophy of Education 301, 302, 303, and 304. Students applying for admission must present an average of 3.75 for the last sixty hours of

undergraduate work; applications of students with averages below 3.75 but above 3.5 are considered on an individual basis. The adviser for candidates for this degree is Professor G. A. Russell, 215 Physics Building. See pages 36 and 37.

For information concerning applied mathematics, see page 292; for information about biophysics, see pages 101, 266, and 270. A doctoral program in chemical physics is described on page 115.

FACULTY

Professors: G. M. Almy (Head of Department), A. Abashian, F. T. Adler, J. S. Allen, D. Alpert, A. C. Anderson, G. Ascoli, P. Axel, J. Bardeen, G. A. Baym, F. C. Brown, R. M. Brown, M. K. Brussel, W. D. Compton, C. B. Duke, C. P. Flynn, L. D. Fosdick, H. Frauenfelder, D. M. Ginsberg, A. V. Granato, P. Handler, A. Hanson, J. P. Hummel, M. V. Klein, J. S. Koehler, L. J. Koester, P. G. Kruger, U. E. Kruse, L. S. Lavatelli, D. Lazarus, E. M. Lyman, D. E. Mapother, R. J. Maurer, B. H. McCormick, J. R. Pasta, D. Pines, M. Raether, D. G. Ravenhall, C. S. Robinson, G. A. Russell, C. T. Sah, R. D. Sard, C. B. Satterthwaite, R. O. Simmons, C. P. Slichter, J. H. Smith, J. N. Snyder, H. J. Stapleton, A. Wattenberg, W. S. Williams, H. W. Wyld, M. E. Wyman.

Associate Professors: J. H. Cahn, P. G. Debrunner, L. E. Holloway, S. Ichimaru, E. A. Jackson, T. A. O'Halloran, R. N. Peacock, F. M. Propst, R. L. Schult, J. D. Stack, J. D. Sullivan, D. C. Sutton, M. Wortis, J. A. Wright.

Assistant Professors: H. Bohmer, S. Chang, R. A. Deegan, B. I. Eisenstein, L. M. Jones, J. M. Mochel, D. W. Mortara, M. B. Salamon, B. A. Sherwood, J. S. Trefil.

COURSES FOR GRADUATES

400. Problems and Methods of Mathematical Physics. Matrices and tensors; analytic functions of a complex variable; conformal mapping; contour integration; ordinary differential equations; solutions at singular points, contour integral solutions, asymptotic expansions; eigenfunctions and eigenvalues; partial differential equations; Laplace's equation, wave equation, diffusion equation, Green's functions; Legendre, Bessel, confluent hypergeometric, Mathieu, and elliptic functions; elementary difference equations. 1 unit. Prerequisite: Mathematics 342, 345, 347, or 387; Physics 322 and 342; or consent of instructor.

422. Dynamics and Nonlinear Mechanics. Hamiltonian mechanics; Lagrange equations, Hamilton's canonical equations, contact transformations, Lagrange and Poincaré invariants, Hamilton-Jacobi equation and Huygens' principle; perturbation theory, relaxation oscillations and stability of periodic motion, theory of cosmotron orbits, three-body problems. 1 unit. Prerequisite: Physics 322; Mathematics 345.

424. Relativity and Cosmology. Same as Astronomy 424 and Mathematics 460. Elements of tensor calculus and Riemannian geometry; special relativity: Lorentz transformations, equivalence of mass and energy; general relativity and the gravitational field of the sun; galaxies and cosmology. 1 unit. Prerequisite: Consent of instructor.

430. Surface Physics. Same as Metallurgical Engineering 430. Introduction to theory and experiment on atomic behavior of crystal surfaces; thermodynamics of surfaces; surface energy; diffraction and structure; gas-solid collisions; Brownian motion, diffusion and evaporation; electron and ion emission, tunnelling; Van der Waals forces; theory of chemical interactions; kinetics and statistics of absorption. 1 unit. Prerequisite: Metallurgical Engineering 421 or Physics 489, or consent of instructor.

435. Theory of Semiconductors and Semiconductor Devices. Same as Electrical Engineering 435. Introductory quantum mechanics of semiconductors; energy bands; dynamics of Bloch electrons in static and high frequency electric and magnetic fields; equilibrium statistics; transport theory, diffusion, drift and thermoelectric effects;

characteristics of p-n junctions, heterojunctions and transistor devices. 1 unit. Prerequisite: Senior-level course in quantum mechanics or atomic physics.

436. Selected Topics in Physics of Solids. The following topics are offered in rotation, one or two each semester.

(a) Imperfections in Metals. Influence of point imperfections such as lattice vacancies and interstitial atoms on diffusion and on such physical properties as resistivity, stored energy, lattice parameter, density; properties of dislocations and stacking faults and their influence on mechanical properties, on physical properties, on crystal growth, and on phase changes. 1 unit. Prerequisite: Physics 490.

(b) Imperfections in Ionic Crystals. Theory of vacancies, interstitial ions, dislocations, and excitons; applications to diffusion, ionic conductivity, chemical reactions in the solid state, and plastic flow; effect of imperfections upon the electronic and optical properties of ionic crystals. 1 unit. Prerequisite: Physics 490.

(c) Magnetic Properties of Solids. Quantum theory of diamagnetism, paramagnetism, ferromagnetism; elements of magnetic resonance and relaxation. 1 unit. Prerequisite: Physics 490 or consent of instructor.

441. Electrodynamics. Electrostatics; Laplace's and Poisson's equations; boundary value problems; spherical harmonics; multiple potentials; dielectrics; microscopic and macroscopic fields; electric susceptibility; magnetostatics; magnetic multipoles; magnetic media; conducting media; Maxwell's equations; field energy and momentum; electromagnetic waves; reflection and refraction; dispersion; wave packets; causality; diffraction; wave guides and cavity resonators; simple aspects of magnetohydrodynamics and plasmas. 1 unit. Prerequisite: Physics 342 or equivalent; registration in Physics 400 or consent of instructor.

442. Electrodynamics. Special theory of relativity; covariant formulation of electrodynamics; charged particle dynamics; high energy particle accelerators; energy loss by charged particles traversing matter; multiple scattering; Lienard-Wiechert potentials; radiation by charged particles; radiation loss in particle accelerators; Thomson scattering; bremsstrahlung; Weiszacker-Williams method; inner bremsstrahlung; Cerenkov radiation; radiative reaction; natural line breadth; multiple expansion of radiation field; Lagrangian and Hamiltonian formulation of electrodynamics. 1 unit. Prerequisite: Physics 441.

455. Reactor Physics, I. Same as Nuclear Engineering 455. An introduction to the physical concepts of reactor analysis; nuclear cross sections, diffusion, slowing down, and thermalization of neutrons; homogeneous reactor theory; introduction to heterogeneous reactor theory and reactor kinetics; computer applications in reactor analysis. 1 unit. Prerequisite: Nuclear Engineering 347, Mathematics 343 and 345, or consent of instructor.

456. Reactor Physics, II. Same as Nuclear Engineering 456. Neutron transport theory; current methods of solution of the transport equation; fast and thermal neutron spectra; applications in heterogeneous reactor analysis and other areas of reactor physics; digital computer methods. 1 unit. Prerequisite: Physics 455 or consent of instructor.

462. Statistical Mechanics and Kinetic Theory. Single-particle distribution functions: classical and quantum mechanical systems, Boltzmann equation, virial theorem, equations of state for gases; formal theory: ensembles, identical particles, thermodynamics of simple systems, distribution functions; non-equilibrium problems: conservation laws and hydrodynamics equations, sound waves, transport coefficients; plasmas, normal Fermi fluid, superfluids, systems with internal degrees of freedom. 1 unit. Prerequisite: Physics 360 and elementary quantum mechanics, or consent of instructor.

463. Low Temperature Theory and Quantum Liquids. Normal Fermi liquids: equilibrium properties, transport equation, quasi-particle collisions, degenerate He^3, Landau theory; formal description of experimental measurements in neutral and charged Fermi liquids; superfluid Bose liquid: He II, rotating buckets, macroscopic description of

superfluid flow, two-fluid model, first, second, and quasi-particle sound, vortex lines, microscopic theory; superconductivity: BCS theory, electrodynamics and coherence effects, superconductivity in metals, tunnel effect, flux quantization, microscopic theory of superfluid flow, vortices. 1 unit. Prerequisite: Physics 462, 481, or consent of instructor.

465. Plasma Physics. Basic equations of magnetohydrodynamics; orbit theory; stability of plasma configurations; hydromagnetic waves; plasma oscillations; high-frequency instabilities; spontaneous fluctuation theory; Fokker-Planck equation; transport processes; oscillations in a magnetic field; interaction of electromagnetic waves with plasmas. 1 unit. Prerequisite: Physics 362 and 441, or Electrical Engineering 423, or consent of instructor.

467. Atomic Collision Processes. Same as Electrical Engineering 467. Elastic collisions of electrons with neutral atoms; inelastic electron-atom and electron-molecule collisions; collisions between heavy particles; molecule formation; photo-processes and recombination; negative ions; collisions involving the emission of radiation; theory of spectral line-broadening in plasmas; experimental techniques. 1 unit. Prerequisite: Physics 480 or consent of instructor.

470. Introduction to Nuclear and Particle Physics. Basic facts of photons, leptons, hadrons, conservation laws, types of interaction, particle production and stability symmetries, nuclear forces, and ground state properties; two-particle systems: electromagnetic interactions, bound states, and resonances; nucleon-nucleon and meson-nucleon interactions; nuclei: properties of low-lying states, models, resonant reactions, and direct processes; particles and weak interactions: multipion resonances, symmetry schemes, beta decay and other leptonic processes, strange particle decays. 1 unit. Prerequisite: Physics 480 or consent of instructor.

471. Nuclear Physics, I. Systematics of stable nuclei and the nuclear potential; properties of odd-A nuclei; spherical single particle shell model; residual interactions: collective states and deformed nuclei; summary of theory and experiment for low-lying states; momentum distribution of nucleons; fission. 1 unit. Prerequisite: Physics 470.

472. Nuclear Physics, II. Resonance reactions: fast and slow neutron cross sections, neutron and gamma widths, strength functions, giant dipole resonance, compound nucleus, and statistical model; direct reactions: optical model, elastic and inelastic scattering, polarization, angular correlations; spectroscopic factors, intermediate structure, isobaric analogs. 1 unit. Prerequisite: Physics 471.

475. Particle Physics, I. Particles: properties and systematics; S-matrix theory; application of symmetry and invariance principles to decays, production processes and polarization; collision processes; mesonic and baryonic resonances; symmetry schemes; particle scattering at very high energies; theory of pion-nucleon scattering, dispersion relations, Mandelstam representation. 1 unit. Prerequisite: Physics 470.

476. Particle Physics, II. Electromagnetic interactions of particles, form factor, predictions of unitary symmetry; beta and muon decay and capture, conserved and partially conserved currents, neutrino interactions, weak interaction form factors; leptonic and non-leptonic decays of strange particles; neutral K-meson decays; current topics. 1 unit. Prerequisite: Physics 475.

477. Seminar in High-Energy Physics. Under the guidance of faculty, students study and report on topics of current interest in high-energy physics. $\frac{1}{2}$ unit. Prerequisite: Physics 470 or consent of instructor.

480. Quantum Mechanics, I. A second course in quantum mechanics for students with a good background in wave mechanics and atomic and molecular structure. Operators, state vectors and the formal structure of quantum theory, operator treatments of simple systems; angular momentum, vector addition coefficients; stationary state perturbation theory; introduction to scattering theory for particles without spin, partial wave analysis, Born approximation; with examples taken from atomic, nuclear, and elementary particle physics. 1 unit. Prerequisite: Senior-level atomic physics and quantum mechanics, or consent of instructor.

481. Quantum Mechanics, II. Spin and identical particles, simple many-particle systems and elements of second-quantization theory; time-dependent processes, radiative transitions, quantization of the electromagnetic field; scattering of particles with spin, polarization; introduction to the Klein-Gordon and Dirac equations, properties of simple relativistic systems. 1 unit. Prerequisite: Physics 480 or consent of instructor.

483. General Field Theory. A course covering the standard techniques of field theory, as used by experimenters and theorists. Relativistic quantum mechanics of a single particle; Lagrangian field theories, perturbation theory, calculation of lowest-order processes; introduction to Feynman diagrams, higher order processes, examples taken from quantum electrodynamics, solid-state and elementary particle physics and many-body theory. 1 unit. Prerequisite: Physics 481 or consent of instructor.

485. Advanced Field Theory. Renormalization theory, dispersion relations, S-matrix theory; current algebra; recent developments 1 unit. Prerequisite: Physics 483 or consent of instructor.

489. Solid State Physics, I. Introduction to the modern theory of crystalline materials. Topics treated include crystal symmetry, elastic and thermal properties of solids, optical properties, point defects and imperfections in crystals. 1 unit. Prerequisite: Physics 360, 362, 381, 480, or consent of instructor.

490. Solid State Physics, II. Introduction to band theory of solids, free electron model, electrons in periodic potential, cohesion, transport properties of metals and semiconductors, experimental methods for determining band structure. 1 unit. Prerequisite: Physics 489 or consent of instructor.

491. Solid State Physics, III. Elementary excitations in solids; phonons, electrons, plasmons, excitons, spin waves, treated as elementary excitations in interaction with one another and with external fields and particles. 1 unit. Prerequisite: Physics 481.

497. Individual Study. Individual study in a subject not covered in course offerings may be arranged for credit by registration under this number. ½ or 1 unit.

498. Special Topics in Modern Physics. Seminar. Lecture courses in topics of current interest are given under this number. Subjects are announced in the Time Table. ½ or 1 unit.

499. Thesis Research. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. Modern Experimental Physics, I. Techniques and experiments in the physics of atoms, atomic nuclei, molecules, the solid state, and other area of modern physical research. 1 unit. Prerequisite: Physics 342; registration in Physics 381.

304. Modern Experimental Physics, II. Continuation of Physics 303. 1 unit. Prerequisite: Physics 303.

321. Theoretical Mechanics. Motion of a particle in one, two, and three dimensions with applications; Kepler's laws and planetary motion; scattering of particles; conservation laws; motion of a rigid body in two dimensions; statics of extended systems. Lectures and problems. 1 unit; no graduate credit is given to graduate physics majors. Prerequisite: General physics; registration in Mathematics 341, 345, or 349.

322. Theoretical Mechanics. Continuation of Physics 321. Moving coordinate frames, fictitious forces; special theory of relativity, conservation laws, particle motion and creation; rigid body motion in three dimensions; gravitation and earth motion; generalized coordinates and Lagrange's equations; constraints, small vibrations. 1 unit. Prerequisite: Physics 321.

341. Electricity and Magnetism. The fundamental laws are introduced using the vector notation stressing Maxwell's equations in the integral form. Topics covered with applications and problems include direct current circuits, circuit theorems, electric and magnetic fields, Gauss' Law, capacitance and inductance; energy and forces associated

with these fields in free space and in matter. Lectures, problems, and laboratory. This course is fundamental to advanced courses and should be elected as early as possible by those intending to specialize in physics. ½ or 1 unit; no graduate credit is given to graduate physics majors. Prerequisite: General physics; credit or registration in Mathematics 341, 343, or 345, or consent of instructor.

342. Electricity and Magnetism. Continuation of Physics 341. Effects associated with changing fields and currents, Faraday's Law, displacement current, transient currents, complex variables in circuit analysis, coupled circuits, and circuit theorems; an introduction to the generation and propagation of electromagnetic waves and the wave equations. ½ or 1 unit; no graduate credit is given to graduate physics majors. Prerequisite: Physics 341.

343. Electronic Circuits. The physics of vacuum tube and semiconductor devices; theory and application of these devices as linear circuit elements in power supplies, amplifiers, communication circuits and control circuits. Emphasis is on experimental techniques. Lectures, problems, and laboratory. 1 unit. Prerequisite: Physics 341 or consent of instructor.

344. Electronic Circuits. Continuation of Physics 343. Electronic instruments and techniques used in research in physics and digital computers; theory and experiments emphasizing the use and design of nonlinear circuits, e.g., multivibrators, pulse generators, counters, etc.; theory of switching circuits; special topics. 1 unit. Prerequisite: Physics 343 or equivalent.

347. Electromagnetic Theory and Boundary Value Problems. Beginning with Maxwell's equations, this course treats electrostatic and magnetostatic boundary value problems and multipole expansions with orthogonal polynomials, boundary value problems in quasistatic and radiation fields, simple radiating systems, and scattering of scalar waves. 1 unit. Prerequisite: Mathematics 343 and 345, Physics 342 or Electrical Engineering 229; or consent of instructor.

360. Thermodynamics. Zeroth, first, second, and third laws of thermodynamics; applications to simple physical and chemical systems; thermodynamic inequalities and equilibrium; phase transitions. Lectures and problems. 1 unit. Prerequisite: General physics and calculus; senior standing in physics is advised.

362. Kinetic Theory and Statistics. A lecture and problem course presenting the fundamentals of kinetic theory and an elementary introduction to statistical mechanics. Topics covered include the distribution law, equations of state, viscosity, diffusion, thermal conduction, Maxwell-Boltzmann, Bose, Einstein, and Fermi-Dirac statistics and applications. 1 unit. Prerequisite: Physics 360 or consent of instructor.

366. Aeronomy: Physics of the Upper Atmosphere and Space. Same as Astronomy and Electrical Engineering 366. Structure and composition of the Earth's upper atmosphere; solar radiation and its interaction with the upper atmosphere; the ionospheric layers; planetary atmospheres; airglow and aurora; interplanetary plasma; the magnetic field of the Earth and its interaction with the solar plasma; experimental techniques. 1 unit. Prerequisite: Physics 342, 321 and 381, or consent of instructor.

371. Light. Wave optics: description and superposition of waves, coherence, interference, diffraction, polarization, and dispersion. Geometrical optics: image formation, optical systems, thick lens theory, image defects; applications to optical instruments. Lectures, problems, and laboratory. ½ to 1 unit. Prerequisite: General physics; Mathematics 345 or consent of instructor.

381. Atomic Physics. Same as Chemistry 396. A lecture and problem course presenting our modern knowledge of the nature and properties of electrons, light quanta, atoms, and molecules. Topics discussed include evidence for the atomic nature of matter, the properties of free electrons and ions, photons and their interaction with matter, atomic spectra and structure, molecular spectra and structure, and an introduction to the ideas of quantum mechanics. A student may not receive credit for both Physics 381 and 386. 1 unit. Prerequisite: General physics and Mathematics 343 or 345.

382. Nuclear Physics. A lecture and problem course presenting our modern knowledge of the properties of nuclear particles, natural and artificial radioactivity, laboratory equipment for producing and studying high energy particles, nuclear disintegrations, the interaction of nuclear particles with each other and with matter, cosmic rays, mesons, and recent developments in high energy nuclear physics, and the application of nuclear phenomena to some practical problems. 1 unit. Prerequisite: Physics 381 or 383.

383. Atomic Physics and Quantum Theory. Introduction to the basic concepts of quantum theory which underlie modern theories of the properties of materials. Topics covered include elements of atomic and nuclear theory, kinetic theory and statistical mechanics, quantum theory, and simple applications, atomic spectra and atomic structure, molecular structure and chemical binding. Lectures and problems. $^3/_4$ or 1 unit. Prerequisite: General physics; general chemistry; Mathematics 345 or equivalent.

385. Introduction to Quantum Mechanics. Experimental foundation; basic postulates; Schrödinger wave equation; hydrogen atom; superposition of states; the calculation of energy, position, momentum and angular momentum; steady state perturbation theory; identical particles, time-dependent perturbation theory; introduction to Dirac theory. The course emphasizes basic principles applied to simple examples, many of them one-dimensional. Numerical methods for the solution of eigenvalue problems are used extensively. Recommended to physics majors and also to students in other physical sciences and engineering. A student may not receive credit for both Physics 385 and 387. 1 unit. Prerequisite: Mathematics 343, 345, or consent of instructor.

386. Atomic Physics and Quantum Mechanics, I. Study of atomic phenomena integrated with an introduction to quantum theory; topics discussed include evidence for the atomic nature of matter and the properties of the Schrödinger equation, single particle solutions in one dimension, the hydrogen atom, perturbation theory, external fields, and atomic spectroscopy of outer electrons. A student may not receive credit for both Physics 381 and 386. 1 unit. Prerequisite: General physics; Mathematics 343 or 345, or consent of instructor.

387. Atomic Physics and Quantum Mechanics, II. Topics treated include identical particles, spectral hyperfine structure, magnetic properties of matter, atomic spectroscopy of inner electrons, high energy photon effects, molecular, binding and spectra, emission and absorption of light, and symmetry principles. A student may not receive credit for both Physics 385 and 387. 1 unit. Prerequisite: Physics 386.

PHYSIOLOGY AND BIOPHYSICS

See descriptions and course listings under Life Sciences, page 265.

PLANT PATHOLOGY

Graduate work leading to the Master of Science and Doctor of Philosophy is available in the Department of Plant Pathology. Students may choose a major, joint major, or minor in in plant pathology. The following fields are available for specialization: diseases of field crops, forest and shade trees, fruit crops, ornamentals, turf and lawn grasses, and vegetable and canning crops. The student may also specialize in plant virology, nematology, fungicides, antibiotics, physiology of fungi, and biochemistry of plant diseases.

A candidate for the Master of Science must meet the general requirements of the Graduate College, present an acceptable thesis, and pass an oral examination before a committee of staff members. The examination covers courses which the candidate has completed and those in which he is currently registered.

Candidates for the Doctor of Philosophy must meet the general requirements of the Graduate College.

Beginning graduate students are accepted with a grade-point average of 3.75. Applica-

tions of students with grade-point averages of 3.5 and below 3.75 are considered on an individual basis.

FACULTY

Professors: W. M. Bever (Head of Department), L. M. Black, J. C. Carter, J. L. Forsberg, J. W. Gerdemann, D. Gottlieb, A. L. Hooker, M. B. Linn, D. Powell, M. C. Shurtleff, J. B. Sinclair, D. P. Taylor, H. H. Thornberry.
Associate Professors: D. W. Chamberlain, P. D. Shaw.
Assistant Professors: D. I. Edwards, L. E. Gray, W. Hartstirn, H. Jedlinski, R. B. Malek, J. D. Paxton, D. F. Schoeneweiss.

COURSES FOR GRADUATES

401. Diseases of Forest and Shade Trees. A survey of the history, symptomatology, causes, and control of diseases of trees, with assigned reading and performance of illustrative experiments in the laboratory, greenhouse, and field. Offered in 1970-1971 and in alternate years. ½ or 1 unit. Prerequisite: Plant Pathology 204 or consent of instructor. Carter.

403. Physiology of Fungi. Same as Botany 403. The germination, growth, metabolism, and sporulation of fungi; physiology of the fungi as related to parasitism, antibiotic production, vitamin assay, and industrially important products. The nature of fungicidal activity is discussed. Offered in 1971-1972 and in alternate years. 1 unit. Prerequisite: Plant Pathology 204 or equivalent; organic chemistry or biochemistry; mycology and microbiology. Gottlieb.

404. Plant Virology. Fundamental concepts; classification, symptomatology; infectivity; biological, chemical, and physical properties; techniques for transmission, straining, assay, filtration, and purification; control methods; sources of information; history of virology. Offered in 1970-1971 and in alternate years. ½ or 1 unit. Prerequisite: Consent of instructor. Thornberry.

406. Genetics of Plant-Pathogen Interactions. The genetics and expression of resistance in plants to fungi, bacteria, viruses, nematodes, and other pathogens; variation and genetic systems in pathogens with particular emphasis on pathogenicity; complementary genetic systems; theory and practice of breeding disease resistant plants. Lectures, discussions, assigned reading, and term paper. Offered in 1970-1971 and in alternate years. 1 unit. Prerequisite: Plant Pathology 204 and Botany 210, or Agronomy or Horticulture 323, or consent of instructor. Hooker.

417. Discussions in Plant Pathology. Discussion of current research, literature, and other topics pertaining to plant pathology and related fields. ¼ unit. Staff.

499. Thesis Research. Individual study and research required of all students working toward the Master of Science or Doctor of Philosophy in Plant Pathology. 0 to 4 units. Prerequisite: Plant Pathology 302 or equivalent. Work can be taken in the following areas, subject to approval of the staff member concerned:

(a) **Biochemistry of Plant Disease.** Staff.
(b) **Diseases of Corn; Genetics of Resistance.** Hooker.
(c) **Diseases of Cereal Grains.** Bever, Hooker, Shurtleff.
(d) **Diseases of Forest and Shade Trees.** Carter.
(e) **Diseases of Fruit Crops; Fungicides.** Powell.
(f) **Diseases of Leguminous Crops; Root Diseases.** Gerdemann.
(g) **Diseases of Turf and Lawn Grasses.**
(h) **Diseases of Soybeans.** Chamberlain, Paxton, Sinclair.
(i) **Diseases of Vegetable and Canning Crops.** Linn, Shurtleff.
(j) **Nematode Diseases.** Edwards, Malek, Taylor.
(k) **Physiology of Fungi; Antibiotics.** Gottlieb, Shaw.
(l) **Plant Virology.** Black, Jedlinski, Thornberry.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Special Problems. For students desiring to study specific problems not assigned in other courses. 1/4 to 1 unit; maximum accumulated credit, 2 units. STAFF.

302. Research Methods in Plant Pathology. Techniques for the isolation, identification, culture of, and inoculation with plant pathogens; methods for the histological study of diseased plants; recording of data. 3/4 unit. Prerequisite: Plant Pathology 204 or equivalent. PAXTON.

303. Plant Nematology. Experimental techniques, nematode anatomy, taxonomy, biology, and host-parasite relations; intensive study of selected groups including foliar, stem, root-knot, and cyst nematodes; interaction with bacteria, fungi, and viruses in plant disease development; control principles. Offered in 1970-1971 and in alternate years. 3/4 unit. Prerequisite: Plant Pathology 204 or equivalent; an introductory course in zoology or biology. TAYLOR.

304. Forest Tree Diseases and Wood Deterioration. Symptoms, causal agents, and control of the major forest tree diseases; causes and control of wood deterioration. 3/4 unit. GERDEMANN.

305. Principles of Plant Disease Control. A study of the basic concepts of both nonchemical and chemical methods used for the control of plant diseases. Lectures, discussions, and assigned reading. Offered in 1971-1972 and in alternate years. 3/4 unit. Prerequisite: Plant Pathology 204; Chemistry 102, 132 or 133; or consent of instructor. TAYLOR.

306. Epiphytology and Diagnosis of Plant Diseases. Detailed consideration of factors influencing the incidence and severity of diseases caused by fungi, bacteria, viruses, and nematodes; ecological factors as etiological agents, and techniques for determining the intensity of epiphytotics; plant disease identification. Offered in 1971-1972 and in alternate years. 3/4 unit. Prerequisite: Plant Pathology 204 or equivalent. SINCLAIR.

377. Diseases of Field Crops. Same as Agronomy 377. A study of the symptoms of the major field crop diseases, life histories of causal organisms, and methods of control. Offered in 1971-1972 and in alternate years. 3/4 unit. Prerequisite: Plant Pathology 204 or equivalent. HOOKER.

POLITICAL SCIENCE

The Department of Political Science offers work leading to the degrees of Master of Arts and Doctor of Philosophy. Graduate work is conducted in the following special fields: American government and politics, comparative government and politics, international law and relations, political behavior, political theory and jurisprudence.

Admission to graduate work in political science requires a grade-point average of at least 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis. The student must also have had a minimum of twenty hours of undergraduate work in political science, economics, finance, sociology, or history, not less than twelve hours of which must have been in political science (which may include three hours in constitutional history). For additional information, contact the department, 326 Lincoln Hall.

The department also administers a program leading to the Master of Arts in Public Administration. A grade-point average of at least 3.75 and a study proposal leading to a well-defined career or professional objective, approved by the department, are required for admission. The program is offered both in Urbana and through extramural classes in Springfield, and is matched to the individual needs and objectives of students. Programs for students without public service employment usually incorporate an internship of at least three months. Further details may be obtained from the department, 326 Lincoln Hall.

Requirements for the master's degree in political science include eight units of credit, an acceptable thesis or substantial research essay in a departmental course, and either a pro-

seminar in American government with a grade of A or B or passing the proficiency examination in American government.

A doctoral candidate must show competence in American politics, political theory, and scope and methods of political science. This competence may be demonstrated either by passing a proficiency in each area upon first entering the department, or by successfully completing specified courses in each of the areas.

A candidate for the Ph.D. must demonstrate (1) a reading proficiency in two languages other than English, or (2) a high degree of proficiency in one language other than English, or (3) a reading proficiency in one foreign language and a working knowledge of statistics, mathematics, or computer programming, or (4) a high proficiency in statistics, mathematics, or computer programming.

A student may satisfy the requirement of a working knowledge in statistics, mathematics, or computer programming by satisfactory completion of two units in one of those subjects, or the equivalent. The two units may not be used as part of the minor requirement. High proficiency involves the satisfactory completion of four units of work in either statistics, mathematics, or computer programming or the equivalent; two of these units may be counted for the minor.

The language requirement may be fulfilled by direct examination by the language department, acceptable score on the Educational Testing Service Language Test, or an A or B in French, German, Spanish, or Russian 401. The high proficiency examinations include both a written and an oral examination, both given by the appropriate language department. Certification of proficiency in foreign languages from other colleges and universities is not acceptable by transfer, but scores on the ETS language tests taken elsewhere are accepted and evaluated. Further information on fulfilling these requirements may be obtained from 326 Lincoln Hall.

Requirements for the Ph.D. also include passing a written and oral preliminary examination after completion of sixteen units. The preliminary examination tests competence in three areas of political science and in one outside minor area.

Graduates in other departments who choose political science as a minor must have at least six hours of undergraduate work in political science and three hours in other social sciences.

FACULTY

Professors: P. Monypenny (Head of Department), M. Davis, S. K. Gove, E. G. Lewis, N. E. Long, E. J. Meehan, R. L. Merritt, S. S. Nagel, J. W. Peltason, R. E. Scott, C. F. Snider, V. A. Thompson.

Associate Professors: I. H. Carmen, Betty Glad, M. Hobbs, G. Manner, R. F. Miller, T. Page, M. G. Weinbaum, G. T. Yu.

Assistant Professors: R. S. Byars, B. Carroll, P. Cohen, F. S. Coombs, S. A. Douglas, A. B. Fields, P. Meranto, J. Pisciotte.

COURSES FOR GRADUATES

400. Classics of Political Science. Reading, analysis, and discussion of leading works on politics and government. 1 unit. Staff.

401. History of Political Theories. Reading and analysis of the leading political thinkers from the Greeks to the middle of the seventeenth century. 1 unit. Davis.

402. History of Political Theories. Readings and analysis of the leading political thinkers from the middle of the seventeenth century to the present. 1 unit. Fields.

406. Municipal Administration. Position of cities in American governmental systems; governmental interrelationships; powers; services; current municipal problems. 1 unit.

410. Problems in Rural Local Government. Research in selected topics. 1 unit. Snider.

412. Problems in State Government. Research in selected topics in American state government. 1 unit. Snider.

420. Formation of Public Policy. Same as Labor and Industrial Relations 420. An examination of the institutional and dynamic forces that shape the making of policy and its administration in the United States; separation of powers, pressure groups, administrative and legislative procedures, judicial activity. 1 unit.

421. Government and the Economic Order. Seminar in problems of government regulation of economic activity. This course is concerned with research materials, research papers, and related matters. 1 unit.

423. Proseminar in American Politics. An intensive analysis of major institutions and processes of American politics, national, state, and local; research on selected topics in American government. 1 unit.

425. Personality and Political Process. Rationality and its limits in political processes: the functions of symbols and myth in politics; political involvement and quiescence; nonrational elements in legislation and administration. 1 unit. Prerequisite: Consent of instructor. COOMBS.

426. Political Parties. Special problems in political parties; methods and materials of research in this field. 1 unit. WEINBAUM.

427. Psychological Base of Political Behavior. This course is intended to introduce the student to relations between psychological mechanisms and life history factors and individual or group political behavior. Topics covered include national loyalty and ideology, mass public and political involvement, political authority, and individual compliance. 1 unit. COOMBS.

430. Proseminar in Comparative Politics. Comparative political analysis in the context of the evolution of the social sciences and modern political science, with emphasis on theories of political action and their function in contemporary comparative studies. This course is designed as an introduction to area oriented seminars and generally is a prerequisite for them. 1 unit. STAFF.

431. Problems of British Government. Special topics relating to British government. 1 unit. LEWIS.

435. Problems in the Government of Soviet Russia. Special topics relating to the government of the Soviet Union. 1 unit. MILLER.

437. Problems in Chinese Politics and Government. Research in selected topics relating to the political system of China. 1 unit; may be repeated for credit not to exceed 2 units. Prerequisite: Credit or registration in Political Science 430, or consent of instructor. YU.

440. Comparative Politics and the Political Process. The comparative study of selected national political systems or of specific institutional forces that influence the making and application of public policy in several countries. The countries studied and the legal and extra-legal political agencies considered vary according to the person conducting the seminar. 1 unit; may be repeated for credit not to exceed 3 units. STAFF.

441. Politics in the Developing States. An examination of the political processes in the developing countries. The general problems arising in the transition from traditional societies to modern industrial states are examined to describe the typical patterns of political change. Special attention is given to contemporary literature and studies. 1 unit. Prerequisite: Political Science 430; consent of instructor. SCOTT.

442. Problems of Latin-American Politics and Government. Special topics relating to Latin-American politics and government. Individual countries may be studied or comparative analysis of particular political and governmental functions or problems may be undertaken. 1 unit; may be repeated for credit not to exceed 2 units. Prerequisite: Political Science 430 or equivalent. SCOTT.

446. Problems of Southeast Asian Politics and Government. Research in the political systems of Southeast Asia. 1 unit may be repeated for credit not to exceed 2 units. Prerequisite: Credit or registration in Political Science 430, or consent of instructor. DOUGLAS.

448. Problems in Japanese Politics and Government. Study of scholarly literature on modern Japanese politics and exmination of selected problems in modern Japanese politics. 1 unit; may be repeated for credit not to exceed 2 units. Prerequisite: Credit or registration in Political Science 430, or consent of instructor.

449. Problems of South Asian Politics and Government. Research in the political systems of South Asia. 1 unit; may be repeated for credit not to exceed 2 units. Prerequisite: Credit or registration in Political Science 430, or consent of instructor. COHEN.

450. Contemporary Governmental Problems. Special problems of current importance. Designed especially for students not majoring in political science. 1 unit; may be repeated for credit not to exceed 3 units. STAFF.

451. Constitutional Law. Research in selected in the American constitutional system. 1 unit. Prerequisite: Political Science 351 or equivalent. CARMEN, NAGEL.

453. Law, Policy, and Social Science. The application of social science research techniques to improving legal procedure and legal substance. Emphasis is placed on constitutional law and other public law subjects, but other fields of law are also considered. 1 unit. NAGEL.

460. Organizational Sciences, I. Same as Business Administration 410, Psychology 453, and Sociology 456. An introduction to the principal theories and important empirical research in various disciplines that study organizations. In addition to examination of the subject matter content of various disciplines, students critically examinne the capacities and limitations of the various fields to make contributions to the study of organizations. 1 unit. Prerequisite: Enrollment as a major in organizational sciences in a cooperating program or approval of instructor.

461. Organizational Sciences, II. Same as Business Administration 411, Psychology 454, and Sociology 457. An introduction to the principal theories and important empirical research in various disciplines that study organizations. In addition to examination of the subject matter content of various disciplines, students critically examine the capacities and limitations of the various fields to make contributions to the study of organizations. 1 unit. Prerequisite: Political Science 460.

465. Problems in Administrative Management. An analysis of methods of applying administrative principles and procedures to operating problems in government agencies, such as methods of administrative coordination and control, intergovernmental cooperation, legislative-administrative relations, the organization of regulatory functions, and review of administrative decisions. 1 unit. Prerequisite: Political Science 361 or consent of instructor. MONYPENNY, PAGE.

466. Current Administrative Theory. A discussion of some recent trends in administrative opinion and practice on such questions as agency structure and functional activities; field and regional organization and relations; the role and functions of the executive; the process of decision making; the relations of line and staff activities; the communication and execution of policies and programs; and employee relations. 1 unit. MONYPENNY, THOMPSON.

471. Problems in International Organization. Methods and materials of research in international organization; special topics, such as disarmanent, security, procedural problems in the United Nations, economic and social problems, amendment and revision of the Charter. 1 unit.

481. Foreign Relations of the United States. Special problems in the development and conduct of American foreign policy. 1 unit.

482. United States Foreign Policies. Study of selected current problems in foreign policy; use of power; problems of negotiation; relations with new states; foreign aid. 1 unit.

484. International Relations. An analysis of the approaches and methods used in the study of international relations; the characteristics of states and of international systems; the problem of conflict and its resolution. 1 unit. GLAD, MERRITT.

485. International Law. Research on selected topics. 1 unit. MANNER.

490. Proseminar in Political Behavior. Interdisciplinary approaches to the analysis of political behavior; formation of opinions, interests, roles, and personality; applications of organization theory to political institutions; applications of conflict and bargaining theory to political processes; systematic studies of the distribution of values. 1 unit. COOMBS, HOBBS, MONYPENNY.

491. Proseminar in Political Behavior. Interdisciplinary approaches to the analysis of political behavior; formation of opinions, interests, roles, and personality; applications of organization theory to political institutions; applications of conflict and bargaining theory to political processes; systematic studies of the distribution of values. 1 unit. Prerequisite: Political Science 490. COOMBS, HOBBS, MONYPENNY.

492. Problems of Explanation in Social Science. Special topics in the methodology of social sciences, especially theory formation, theory testing. 1 unit. MEEHAN.

493. Research in Selected Topics. Research in selected topics by arrangement with the instructor. ½ to 3 units. STAFF.

494. Systematic Social Criticism. Problems of social criticism in contemporary society; relation of social criticism and social policies. 1 unit. Prerequisite: Political Science 492 or consent of instructor. MEEHAN.

495. Scope and Methods of Political Science. Definitions of the scope and subject matter of political science; methodological issues in political science; major conceptions of methodology as embodied in current leading studies of politics; the present state of research in political science. 1 unit. HOBBS, MONYPENNY.

496. Political Concepts: Formulation and Measurement. The course is designed to indicate the relevance of certain research techniques for answering questions of concern in political science and to indicate the range of tools available to the student. Problems in concept formation are discussed. Current methods of concept measurement are presented to the student in the context of political research problems. 1 unit. Prerequisite: Consent of instructor.

497. Research Design and Techniques. This course is intended to introduce the student to problems of research design, data collection, data analysis and interpretation, sampling, and some simple measures of statistical association and significance. 1 unit. Prerequisite: Political Science 496.

498. The Logic of Political Inquiry: Selected Topics. Application of analytic principles and procedures developed in Political Science 495 to such topics as: patterns of explanation; current theoretical perspectives; group theory, functionalism, systems theory, decision making, simulation, etc.; the logic of judicial decisions; justifications of political ideologies. This list is not exhaustive, nor will all of these topics be included each semester. 1 unit; may be repeated for credit not to exceed 2 units. Prerequisite: Political Science 495. HOBBS.

499. Thesis Research. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

305. Municipal Government. Growth of cities; their legal status; municipal politics and organization in the United States. ½ or 1 unit. LONG, MERANTO.

306. Municipal Problems. Municipal administration in the United States; administrative organization; personnel problems; financial problems, city planning and housing; police and fire administration; public health; public utilities. ½ or 1 unit. Prerequisite: Political Science 305, or Economics 102 and 103, or six hours of political science. GOLD.

310. Rural Local Government. Development of local government in rural America; state-local relationships; legal status of local units; organization and functions of counties, townships, school districts, and special-purpose districts; rural politics and elections; local finance; problems of reorganization. ½ or 1 unit. SNIDER.

312. State Government. The states in the federal system; state constitutions and problems of revision; organization, powers, and functions of the legislative, administrative, and judicial branches of state government; state functions; reorganization problems in the states; state-local relations; state finance; trends and prospects. Students are not given credit for both Political Science 110 and 312. ½ or 1 unit. Prerequisite: Political Science 150 or 191. SNIDER.

315. Legislatures and Legislation. The legislative function in government; structure and organization of American legislatures, national, state, and local; party organization in legislatures; legislative procedure, pressure groups and lobbying; relation of legislature to other branches of government; problems of legislative reorganization. ½ or 1 unit. Prerequisite: Six hours of political science. JOHNSON, WEINBAUM.

317. The American Federal System. The nature, justification, and problems of federalism; coordination of governmental efforts by contract, subsidies, and grants; comparison of federal systems. ½ or 1 unit. Prerequisite: Political Science 150 or 191.

318. Tax Politics and Administration. Interactions among the administrative, legal, and legislative aspects of the fiscal decision-making process at federal, state, and local levels, with emphasis on current issues. ½ or 1 unit. Prerequisite: Political Science 150 or 191.

321. Government and the Economic Order. A survey of public policies of national and state governments regulating economic activity; transportation, electrical utilities, communications, anti-monopoly, agriculture, level of economic activity. ½ or 1 unit. Prerequisite: Two courses in political science or in political science and economics.

326. American Political Parties. Organization and operation of the American party system; relations between national, state, and local organizations; state and national committees; the convention system; the primary; campaign methods and finance. ½ or 1 unit. Prerequisite: Political Science 150 or 191, or consent of instructor. GOLD, WEINBAUM.

328. Introduction to the Study of Political Behavior. An analysis of the interrelations of political attitudes and public policy formation. Special attention is given to the substantive areas of voting behavior, political leadership, and the rise of political mass movements. The course also includes a review of the literature on democratic and authoritarian personality types. ½ or 1 unit. Prerequisite: Political Science 150 or equivalent.

329. Electoral Behavior. A study of the social and psychological motivations behind the individual voting decision, with special emphasis on the relationships between the voting decision and social stability. ½ or 1 unit. Prerequisite: Six hours of political science.

331. British Government. Nature of the British constitution; the crown, ministry, and cabinet; Parliament and elections; the party system; law and the courts; local government; the British Commonwealth. ½ or 1 unit. DAVIS, LEWIS.

335. Government and Politics of the Soviet Union. Evolution, structure, and functioning of the Soviet system of government; the theories, structure, and functioning of the Communist party of the Soviet Union. ½ or 1 unit. MILLER.

336. Governments and Politics in Western Continental Europe. An analysis of the major governmental systems of Continental Europe; the evolution, structure, and functioning of the political institutions of France, Germany, Italy, Spain, Switzerland, and the Scandinavian countries as illustrations of multiparty and dictatorial types of governments. ½ or 1 unit. LEWIS.

337. Government and Politics of China. An introduction to the governments and politics of modern China. ½ or 1 unit. Prerequisite: Six hours of political science. YU.

338. Governments and Politics in the Middle East. An analysis of the transformation of Middle Eastern society from Morocco to Iran as case studies in political modernization. The politics of the area is studied with special reference to causes and character of modernization, role of leadership, ideologies, and institutions; methods and theories for

analyzing political systems undergoing fundamental transformation, and implications for United States policy. ½ or 1 unit. Prerequisite: Six hours of political science.

339. Governments and Politics in Sub-Saharan Africa. Analysis of major political systems in Africa south of the Sahara. Emphais on the development of states and the modification of social and political systems. A general survey of the area is supplemented by a focus on selected countries. ½ to 1 unit. Prerequisite: Six hours of political science.

340. The German Political System. Structures and processes of postwar German politics, with primary emphasis on West Germany; special attention is paid to foreign policy formulation and problems, particularly defense, the Berlin issue, reunification, and relations with Eastern Europe. ½ or 1 unit. Prerequisite: Knowledge of German helpful, but not necessary. MERRITT.

342. Government and Politics in Latin America. A survey of the origin and development of Latin-American political institutions; systems of government; public administrative systems; party government; international policies of Latin-American governments. ½ or 1 unit. Prerequisite: Six hours of political science. BYARS, SCOTT.

343. Political Systems and Structures of Latin-American Countries. The political process, generally of selected Latin-American countries at different levels of political development, with stress on the interaction between political infrastructure and more formal agencies of government. May include cross-national comparison of the function of such factors as political culture, party system, bureaucracy, or the military establishment. ½ or 1 unit. Prerequisite: Political Science 342. BYARS, SCOTT.

345. Theory and Practice of Democratic Government. Theories of the nature and conditions of democracy; contemporary democratic institutions compared and analyzed. ½ or 1 unit. Prerequisite: Political Science 150 or 191. FIELDS.

346. Theory and Practice of Communism. A survey of the international Communist movement; the origins of modern communism and the nineteenth-century development of its doctrines; the Russian Revolution; Lenin and Stalin, the U.S.S.R. as a model for communism; the regional development of Communist parties. ½ or 1 unit. MILLER.

347. Government and Politics of Southeast Asia. A comparative analysis of the political development of the countries of Southeast Asia, the lands to the east of India and south of China, emphasizing the differing approaches to the governing of man and the formation of public policy to be found in these countries. Economic, social, historical, and geographical influences on political development are considered. ½ or 1 unit. Prerequisite: Six hours of political science or consent of instructor. DOUGLAS.

348. Government and Politics of Japan. An introduction to the government and politics of modern Japan. ½ or 1 unit. Prerequisite: Six hours of political science.

349. Governments and Politics of South Asia. A comparative analysis of the political development of India, Pakistan, Ceylon, and the lesser lands of South Asia, emphasizing the differing approaches to the governing of man and the formation of public policy to be found in these countires. Economic, social, historical, and geographical influences on political development are considered. ½ or 1 unit. Prerequisite: Six hours of political science or consent of instructor. COHEN.

350. Law and Society. An introductory study from a social science perspective of the nature of law, law makers, and law appliers; the causes or inputs determining law; and the effects or outputs which law in general produces. ½ or 1 unit. NAGEL.

351. American Constitutional System. Judicial interpretation of the Constitution; separation of governmental powers; relation of state and national governments; control of interstate commerce; jurisdiction of courts. ½ or 1 unit. Prerequisite: Political Science 150 or 191. CARMEN, NAGEL.

352. Comparative Constitutional Law. A comparative analysis of the constitutional law cases from a variety of countries with particular emphasis on how the cases have resolved issues relating to civil liberties and the allocation of power among governmental bodies. ½ or 1 unit. Prerequisite: Political Science 150 or 191. CARMEN, NAGEL.

353. Law and Politics of Poverty. The study of court cases and other materials dealing with the legal rights and obligations of the poor as tenants, consumers, welfare recipients, employees, arrested persons, family members, legal clients, and political participants. The materials emphasize the constitutional, political, and sociological aspects of the legal rights involved including the political process through which relevant judicial and legislative policy is made and applied. ½ or 1 unit. Prerequisite: Political Science 150 or 191. NAGEL.

354. The Judicial Process. A systematic analysis of legal, evidentiary, environmental, and personal factors that influence judicial decision making, with particular emphasis on the application of the scientific method to the study of judicial behavior. ½ or 1 unit. Prerequisite: Political Science 150 or 191. CARMEN, NAGEL.

355. The Constitution and Civil Liberties. A study of free speech, loyalty in a democratic state, citizenship, freedom of religion, rights of persons accused of crime, and government's responsibility to protect persons from racial and religious discrimination, with special attention to the role of law and judges. ½ or 1 unit. Prerequisite: Political Science 150 or 191. CARMEN, NAGEL.

356. Public Administration and the Judicial Process. The scope of administrative powers and their relation to private rights. A comparison of the processes of decision in administrative agencies and in the courts; the interests served by each; the impact of judicial review of administrative decisions upon administrative procedure and policy; the constitutional and statutory bases of review; the legal accountability of public officers versus political accountability. ½ or 1 unit. Prerequisite: Political Science 305 or 351, or consent of instructor. NAGEL.

357. The Process of Law Enforcement. Problems in the procedure of law enforcement including the nature and ramification of crime; the nature and sources of law; character and types of criminal law; structure of the court system and its role in criminal enforcement; agencies of law enforcement—federal, state, and local; interstate crime control; the police and crime detection; prosecution of criminal offenses; problems of judicial procedure; and correctional procedures. ½ unit. Prerequisite: Political Science 150 or 151.

358. Effects of Alternative Legal Policies. The study in a variety of subject matter areas of the actual and potential impact of legislation and judge-made law on the people who are the intended targets of the resulting legal policies. ½ or 1 unit. Prerequisite: Political Science 150 or 191. NAGEL.

349. Jurisprudence. Nature and sources of law; law and the state; law and justice; evolution, arrangement, and subject matter of law. ½ or 1 unit. Prerequisite: Political Science 150 or 191. MANNER.

361. Introduction to Public Administration. Development of administrative organizations; administration and the executive, legislative, and judiciary; principles of organization, including line and staff relationships; the staff services of finance and personnel; formal and informal control. ½ or 1 unit. Prerequisite: Political Science 150 or 191. MONYPENNY, PAGE.

362. Administrative Organization and Policy Development. Dynamics of policy formulation in public administrative agencies; current developments in organizational theory and their significance for public administration; origin of public administrative organizations; interpersonal behavior; large-scale organizations and centralization; external support and opposition; policy formation and problems of compliance. ½ or 1 unit. Prerequisite: Six hours of political science or consent of instructor. THOMPSON.

365. Government and Labor. Same as Labor and Industrial Relations 365. Critical analysis of the relationship between group pressures on government and public policy affecting labor; role of administration in formation of policy; problems and experience of federal agencies operating in the labor fields. ½ or 1 unit. Prerequisite: Political Science 150 or 191.

366. Tools of Public Management. A critical survey of the tools of analysis available to overhead functions of public management in key areas of decision; emphasis on personnel administration and manpower utilization, budgetary processes and fiscal controls, and several methods of administrative analysis—organizational studies, procedures engineering, information processing, and operations research. 1 unit. Prerequisite: Political Science 361 or consent of instructor. MONYPENNY.

371. World International Organization. General development and basic principles of world organization; principles, structure, methods, and actual operation of international governmental institutions; special attention to the United Nations and related agencies and to their evolution from the League of Nations system. ½ or 1 unit.

372. Regional International Organizations. Descriptive and comparative analysis of various regional international organizations, their role in contemporary politics and their relationship to the United Nations system; structure, functions, and accomplishments of North Atlantic Treaty Organization, Southeast Asia Treaty Organization, Organization of American States, and other regional international organizations. ½ or 1 unit.

380. Comparative Foreign Policies. An analysis of the formulation and substance of the foreign policies of select nations of the world. ½ or 1 unit. Prerequisite: Political Science 184 or consent of instructor.

381. American Foreign Relations. Participation in international affairs; presidential initiative; development and organization of the Department of State; diplomatic intercourse; consular service; treaty-making power; development of foreign policy. ½ or 1 unit. Prerequisite: Six hours of political science. GLAD.

382. Contemporary American Foreign Policies. Study of the major foreign policy decisions currently confronting the United States government: analysis of background, principal issues, alternative actions, formulation of policies. ½ or 1 unit. Prerequisite: Political Science 381 or consent of instructor. GLAD.

383. Soviet Foreign Policy. A survey of Soviet foreign policy from 1917 to the present, with emphasis upon the forces shaping this policy. Special attention is given to the interplay of ideology and national interest in policy formulation. ½ or 1 unit. MILLER.

384. International Relations. An examination of contemporary international systems in terms of the types of actors and their goals, various structures of power, and the mechanisms of allocating resources and containing conflict. ½ or 1 unit. Prerequisite: Junior standing. MERRITT.

385. International Law. Nature, sources, and development of international law and certain basic rights and obligations of the subjects thereof. ½ or 1 unit. MANNER.

386. International Law. Responsibility, intercourse, and redress of differences between states. ½ or 1 unit. MANNER.

387. National Security Policy. An examination of the organization and formulation of current American defense policy; the theory of deterrence, with special reference to American and Soviet military strategy; the problems of disarmament and arms control. ½ or 1 unit. Prerequisite: Political Science 184 or consent of instructor. COHEN, LEWIS.

388. The Military and Politics. The role of the military in national and international politics, with special attention given to theories of war and peace, civil-military relations, the military and the political development of Western and non-Western states, and the non-military uses of the military. ½ or 1 unit. Prerequisite: Political Science 184 or 192, or consent of instructor. COHEN.

389. Chinese Foreign Policy. An analysis of the formulation, substance, and conduct of Chinese foreign policy, with emphasis on the period since 1949. Special attention is given to the forces shaping Chinese policy. ½ or 1 unit. Prerequisite: Six hours of political science or consent of instructor. YU.

390. Methods of Political Analysis. Presentation of the analytic processes in the develop-

ment of concepts, hypotheses, and theories. Discussion of the derivation, formulation, and specification of research problems to be related to basic methodologies and modes of analysis. Applications to political science. ½ or 1 unit. Prerequisite: Political Science 150 or 191, or consent of instructor. Hobbs.

393. Classical Political Theory. A consideration of major works of Greek and Roman political theory, and especially of their relevance to modern political analysis and action. ½ or 1 unit.

394. Medieval Political Theory. The development of political theory from the Church Fathers to the sixteenth century: Augustine, Thomas Aquinas, Dante Alighieri, Marsiglio of Padua, Machiavelli, Thomas More, and others; conflicts of church and state, theories of natural law, natural rights, kingship, legitimacy, popular sovereignty, and representative government. ½ or 1 unit. Carroll.

395. Modern Political Theory. A critical analysis of political theories from the sixteenth century to the present. The focus is on the development of such concepts as the nature of man, the role of the state, justice, legitimacy, obligation, individual rights, equality, and mechanisms of maintenance and change. ½ or 1 unit. Fields.

396. Contemporary Political Theory. Major tendencies in Western political theory since 1850; conservatism and constitutionalism; the religious interpretation of the state and economic institutions; Marxism, socialism, and communism; antidemocratic thought and totalitarian regimes. ½ or 1 unit. Meehan.

397. American Political Theory. A survey of American political thought from colonial times to the present. ½ or 1 unit.

PORTUGUESE

See descriptions and course listings under Spanish, Italian, and Portuguese, page 376.

PSYCHOLOGY

The Department of Psychology offers graduate work leading to the degrees of Master of Arts, Master of Science, Doctor of Philosophy, and Doctor of Psychology.

Fields. Doctor of Philosophy programs are offered in the following areas: child development, clinical and counseling, engineering psychology, higher processes, industrial, learning, mathematical models, personality, physiological, psycholinguistics, psychological measurement, school, sensation-perception, and social. The Master of Arts degree is awarded to students in the above programs as an intermediate degree.

Master of Science programs are offered in personnel psychology and measurement psychology.

The Doctor of Psychology degree is restricted to clinical and counseling.

Admission. The candidate for the Master of Arts or Doctor of Philosophy should meet the following departmental requirements: (1) a minimum of fifteen hours in psychology; (2) a laboratory course in experimental psychology and a course in statistics; (3) a one-year course in another laboratory science; (4) a grade-point average of 4.0; (5) high scores on the Graduate Record Examination. Preference is given to students who have some research experience and who have taken mathematics beyond college algebra.

The candidate for the Master of Science program must ordinarily have completed an undergraduate major in applied psychology at the University of Illinois. Students with an average of 3.5 may apply.

The candidate for the Doctor of Psychology should meet the following departmental requirements: (1) a minimum of twenty hours in psychology; (2) a course in statistics and a course in tests and measurements; (3) a minimum of twenty hours selected from anthropology, economics, education, political science, social work, and sociology; (4) a grade-point average of 4.0; (5) high scores on the Graduate Record Examination.

Because it is necessary to limit admissions to graduate study in psychology, it is not possible to accept all applicants who meet the minimal requirements for any of the above programs.

Minor. The prerequisite for a graduate minor in psychology is nine semester hours in undergraduate psychology and a course in statistics.

Requirements for Degrees. The Master of Arts is awarded to candidates who complete satisfactorily eight units of work, including an acceptable thesis. The Doctor of Philosophy is awarded to candidates who go on to complete an approved program in their area of specialization and meet Graduate College requirements for the degree.

The Master of Science is awarded to candidates who complete satisfactorily eight units of work after completing an applied psychology undergraduate major at the University of Illinois.

The Doctor of Psychology is awarded in clinical and counseling psychology when the following requirements have been completed; (1) three years of full-time course work consisting of twenty-four to twenty-eight units, of which twenty units must be at the 400 level; (2) one summer session of orientation in a hospital or clinic plus one summer session of practicum in a hospital or clinic; (3) a preliminary examination administered by a committee appointed by the Dean of the Graduate College; (4) one year of internship following the third year of course work; (5) a report on the year of internship (not a dissertation); (6) a final examination administered by a committee appointed by the Dean of the Graduate College.

Financial Aid. A wide variety of assistantships, traineeships, and fellowships is available for students in the Ph.D. or D.Psych. programs.

FACULTY

Professors: M. W. Weir (Head of Department), J. A. Adams, H. W. Ades, R. C. Anderson, W. R. Ashby, W. C. Becker, S. W. Bijou, R. B. Cattell, J. B. Cohen, F. Costin, D. E. Dulany, C. W. Eriksen, T. N. Ewing, R. E. Flexman, W. M. Gilbert, H. W. Hake, R. Hamlin, J. Hirsch, L. G. Humphreys, J. McV. Hunt, W. E. Kappauf, L. H. Lanier, J. E. McGrath, C. S. Moss, O. H. Mowrer, C. E. Osgood, D. R. Peterson, K. E. Renner, S. N. Roscoe, I. D. Steiner, M. M. Tatsuoka, H. C. Triandis, L. R. Tucker, L. P. Ullmann, M. Wagman, J. S. Wiggins.

Associate Professors: R. S. Bogartz, J. H. Davis, E. Donchin, M. E. Fishbein, L. R. Goulet, K. T. Hill, C. L. Hulin, L. A. Jakobovits, Alice K. Jonietz, R. P. Larsen, W. E. Montague, G. L. Paul, K. G. Scott, D. T. Shannon, R. L. Sprague, J. S. Werry, Nancy A. Wiggins.

Assistant Professors: I. Ajzen, L. C. Ate, W. H. Batchelder, D. Bernstein, J. E. Bowers, W. Brewer, G. L. Clore, Jr., L. B. Cohen, F. Fehr, Angela Folsom, G. B. Graen, G. Z. Greenberg, W. T. Greenough, S. F. Maier, R. Malpass, W. R. Mead, R. J. Menges, R. Peterson, J. Rappaport, W. M. Steinman, A. W. Wicker, R. C. Williges.

COURSES FOR GRADUATES

The prerequisites stated apply to graduate majors in psychology. Students minoring in psychology may, by special permission of instructors, enroll in certain of these courses without having met all the prerequisites.

402. Systematic Psychology. A critical analysis and comparison of modern and contemporary psychological systems. 1 unit. Prerequisite: Twelve hours of psychology. Dulany.

403. Proseminar in General Psychology, I. A brief historical introduction to modern psychology; fundamentals of differential psychology, including the measurement of intelligence, aptitudes, and personality; motivation, emotion, and mechanisms of defense; psychological development; social behavior. 1 unit. Prerequisite: Twelve hours of psychology. J. B. Cohen.

404. Proseminar in General Psychology, II. Sensory processes; perception; fundamental processes in learning; learning theory; special aspects of human learning; language behavior; thinking; logical aspects of psychological theory. 1 unit. Prerequisite: Twelve hours of psychology. J. B. COHEN.

408. Design of Experiments in Psychology. Advanced experimental designs in psychological research; special methods of data analysis. Offered in 1971-1972 and in alternate years. 1 unit. Prerequisite: Psychology 307. KAPPAUF.

409. Psychological Scaling. Same as Sociology 409. Scaling theory and methodology, with emphasis upon measurement in psychophysics, differential psychology, and social psychology. Offered in 1970-1971 and in alternate years. 1 unit. Prerequisite: Psychology 307. BATCHELDER, TATSUOKA, TUCKER.

411. Advanced Physiological Psychology. Detailed examination of the physiological mechanisms in behavior. Research methodology and contemporary literature in the physiology of motivation; learning, perception, and emotion are emphasized. Laboratory demonstrations and problems. 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 311 or equivalent. DONCHIN, GREENOUGH, MEAD.

413. Computer Applications in Social Statistical Research. Same as Computer Science and Sociology 413. Computer procedures for the analysis of sociological and psychological data, including probability matrices, dominance matrices, clique analysis, regression analysis, analysis of variance and covariance, canonical correlations, discriminant analysis, and factor analysis. 1 unit. Prerequisite: Sociology 387 or equivalent in statistics; may be taken concurrently with Sociology 387. DICKMAN.

414. Experimental Personality Research. A laboratory training course emphasizing physiological, perceptual, learning, and genetic approaches to the experimental study of personality. Critical surveys of recent research literature are combined with laboratory training in representative techniques. 1 unit. Prerequisite: Psychology 307 and 404; consent of instructor.

415. Experimental Sensory Psychology. A systematic study of sensory processes, including vision, audition, gustation, olfaction, and somesthesis. Experimental methods, research findings, and theory are emphasized. 1 unit. Prerequisite: Twelve hours of psychology, including a laboratory course in experimental psychology. GREENBERG, KAPPAUF.

416. Perception. Systematic study of methods and research findings in the field of human perception, together with an evaluation of theoretical interpretations. Offered in 1971-1972 and in alternate years. 1 unit. Prerequisite: Twelve hours of psychology. HAKE.

417. Experimental Psychology of Learning, I: Basic Processes. A study of experimental investigation of basic learning processes, with emphasis upon the nature of the problems, experimental procedures, and theoretical significance. 1 unit. Prerequisite: Twelve hours of psychology. MAIER.

418. Experimental Psychology of Learning, II: Human Learning. Data and theories of verbal learning; verbal mediators and their functions in learning and retention; transfer of training; short-term and long-term memory; conceptualizations of the forgetting process. 1 unit. Prerequisite: Twelve hours of psychology or consent of instructor. Adams.

419. Advanced Comparative Psychology. A critical survey of techniques, results, and problems in the study of animal behavior and human behavior from the comparative-evolutionary point of view. Laboratory demonstrations and individual research problems. 1 unit. Prerequisite: Twelve hours of psychology or biology. HIRSCH, LIEBERMAN.

421. Problems in Motivation. 1 unit. Prerequisite: Twelve hours of psychology.

425. Psycholinguistics. Same as Communications and Linguistics 425. A critical survey of methods and theories in the psychological study of the communication process, with emphasis upon linguistic, information-theory and learning-theory approaches, psycho-

linguistic analysis of language decoding and encoding, and the development and measurement of symbolic processes, including meaning. 1 unit. Prerequisite: Consent of instructor. BREWER, JAKOBOVITS, OSGOOD.

426. Research Seminar in Psycholinguistics. Same as Communications and Linguistics 426. Critical discussion of research problems to which psycholinguistic theories and techniques can be applied. Students taking this course plan, execute, and report an original piece of research in this area. ½ or 1 unit. Prerequisite: Psychology 425; consent of instructor. BREWER, JAKOBOVITS, OSGOOD.

427. Engineering Psychology. Experimental psychology applied to the study of man-machine interrelationships; psychological factors in the design of communication and control equipment. 1 unit. Prerequisite: A laboratory course in experimental psychology or equivalent.

428. Higher Process. An examination of method, theory, and research in the study of thinking; status of cognition as a construct; verbal control of behavior; concepts, problem solving, attention, language and thought; cognitive process as a source of motivation. 1 unit. Prerequisite: Twelve hours of psychology, including a laboratory course in experimental psychology. DULANY.

429. Second Language Acquisition and Bilingualism. Same as Linguistics 429. An examination of the field from a psycholinguistic perspective. The following topics are discussed: first vs. second language acquisition, the nature of language aptitude and competence, methods of second language teaching, the nature of bilingualism, and comparative psycholinguistics. 1 unit. Prerequisite: Consent of instructor. JAKOBOVITS.

431. Psychological Measurement in Industry. Application of psychometric methods and the findings of differential psychology to the selection, classification, and performance evaluation of industrial personnel. 1 unit. Prerequisite: Psychology 307 or equivalent. HULIN.

435. Motivation and Morale in Industry. Same as Labor and Industrial Relations 435. Concepts and methods in the study of motivation of employees; determinants of employee attitudes and job satisfaction; modification of attitudes and morale. 1 unit. Prerequisite: Four units of graduate credit in psychology or consent of instructor. HULIN, TRIANDIS.

436. Mathematical Models in Psychology. The course deals with recent developments in mathematical models in psychology. Special emphasis is given to human learning, higher processes, and modern psychophysics. ½ or 1 unit. Prerequisite: One year of calculus; Psychology 306, 307; or consent of instructor. BATCHELDER.

438. Introduction to Clinical Psychology, I. Introduction to clinical psychology as science and profession. Lectures, discussions, demonstrations, and field observations are provided for overview of clinical psychology. 1 unit. Prerequisite: Graduate standing in clinical psychology; consent of instructor. D. R. PETERSON.

439. Introduction to Clinical Psychology, II. Continuation of introductory sequence in clinical psychology. Logical issues in assessment, disposition and behavior change are discussed. Preliminary training in interview and observational methods are initiated. 1 unit. Prerequisite: Psychology 438. D. R. PETERSON.

440. Functional Analysis of Behavior. A lecture and laboratory course in the principles, analysis, and control of behavior with emphasis on operant and respondent conditioning as means of behavior change. ½ unit. Prerequisite: Consent of instructor. R. PETERSON.

441. Personality and Behavior Dynamics. The cross-sectional structure of personality, the basic principles of behavior dynamics and the determinants which shape personality development are described. Special topics include typologies, trait measurement, conflict and anxiety, and mechanisms of defense. ½ unit. Graduate credit is not allowed for both Psychology 350 and 441. Prerequisite: Twelve hours of psychology. CLORE, WIGGINS.

442. Behavior Disorders. A review of the experimental-clinical literature concerning the

behavior disorders, with special reference to their classification and etiology. ½ unit. Prerequisite: Psychology 338 and 440; consent of instructor. ULLMANN.

443. Psychodiagnostics, I. Instruction and practice in the administration and interpretation of individual tests of general intelligence, special abilities, and achievement. 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 390 or equivalent; Psychology 439. SHANNON.

444. Psychodiagnostics, II. Instruction and practice in the administration and interpretation of tests and other instruments used in the assessment of personality, with special emphasis upon projective techniques. 1 unit. Prerequisite: Psychology 443; consent of instructor. SHANNON.

445. Behavior Modification. A critical survey of issues, principles, practice, and research related to modifying human behavior. The course covers psychotherapeutic and somatic approaches; symptomatic relief and personality-restructuring goal-orientations; individual, family, group, milieu, and preventive community intervention. ½ unit. Prerequisite: Psychology 444. Registration in Psychology 447 is strongly recommended. ULLMANN.

446. Laboratories in Clinical Psychology. Intensive practice in techniques of clinical assessment and behavior modification with emphasis on recent innovations. Small sections of the course are formed according to the specialized interests of students and staff. ½ to 1 unit. Prerequisite: Psychology 445.

447. Practicum. Supervised practice in the assessment and modification of problem behavior. ½ unit. A student may reregister for a maximum of one unit. Prerequisite: Credit or registration in Psychology 445 and 446.

448. Practicum in the Study of Individuals. Substantive material on the study of lives, including: consistency and change in personality over time, relationship of mood and personality structure to behavior, techniques for the longitudinal study of individuals, and an evaluation of the case study method. Each student plans and conducts an experiment testing the application of concepts of personality and behavior dynamics to the study of an individual. Intended for students desiring supervised practicum experience in the assessment of normal behavior. ½ or 1 unit. Prerequisite: Psychology 441. RENNER.

449. Medicine in Clinical Psychology. Introduction to areas of medicine and the organization of medical services as appropriate to the practice of clinical psychology. Medical facts, procedures, and viewpoints are presented to enhance the mutual contributions and collaborative efforts of medicine and clinical psychology. ½ unit. Prerequisite: Second-year graduate standing in clinical psychology or consent of instructor.

450. Community Psychology. An introduction to community mental health as an aspect of community psychology. Primary emphases are on the prevention of mental illness, promotion of positive mental health, and provision of continuity of care for the mentally ill in the community itself. ½ unit. Prerequisite: Second-year graduate standing in clinical psychology or consent of instructor. MOSS, RAPPAPORT.

453. Organizational Sciences, I. Same as Business Administration 410, Political Science 460, and Sociology 456. An introduction to the principal theories and important empirical research in various disciplines that study organizations. In addition to examination of the subject matter content of various disciplines, students critically examine the capacities and limitations of the various fields to make contributions to the study of organizations. 1 unit. Prerequisite: Enrollment as a major in organizational sciences in a cooperating program or approval of instructor.

454. Organizational Sciences, II. Same as Business Administration 411, Political Science 461, and Sociology 457. An introduction to the principal theories and important empirical research in various disciplines that study organizations. In addition to examination of the subject matter content of various desciplines, students critically examine the capacities and limitations of the various fields to make contributions to the study of organizations. 1 unit. Prerequisite: Psychology 453.

455. Research Methods in Organizational Psychology. Discussion and analysis of strategies, methods, and techniques of organizational psychological research. Emphasis is given to methods for researching behavioral determinants within interdependent organizational roles. 1 unit. Prerequisite: Psychology 351 or 355 or 359, or consent of instructor. GRAEN.

456. Psychology of Social Communication. Same as Communications 456. Recent developments in method and theory of attitude change through communication; the nature and determinants of informal social communication; the effects of persuasive communications on public opinion; change in intergroup attitudes through communication. 1 unit. Prerequisite: Psychology 351 or equivalent, or consent of instructor. FISHBEIN.

457. Theory and Research in Organizational Psychology. Theory and research on the psychological processes involving the demands of organizations on the behavior of individuals. Emphasis is given to the processes of power, authority, influence, leadership, communications, decision making, and organizational change. 1 unit. Prerequisite: Psychology 455 or consent of instructor. GRAEN.

458. Group Dynamics. A critical review of theory, research, and practic related to group behavior, including factors influencing communication, decision making, group cohesiveness, and productivity. Offered in 1970-1971 and in alternate years. 1 unit. Prerequisite: Six units of graduate credit in psychology including Psychology 351 or equivalent. STEINER.

459. Leadership and Group Effectiveness. Theories of leadership, methodology in research on leadership; leadership and morale; group structure and group productivity; selection and training of leaders; assembling effective groups. Offered in 1971-1972 and in alternate years. 1 unit. Prerequisite: Psychology 351 or equivalent. MCGRATH.

460. Motivation and Personality Development in Children. Theory, method, and research on the interaction of motivational personality, and learning processes and development in children, with emphasis on experimental studies and a social learning theory approach. Class projects involve some laboratory work with children. 1 unit. Prerequisite: Twelve hours of psychology; consent of instructor. HILL.

462. Human Abilities. Analysis of individual differences in human abilities, including historical background, measurement methodology, and functional correlates of abilities. The use of ability measures in both experimental and applied research is considered. Offered in 1971-1972 and in alternate years. 1 unit. Prerequisite: Psychology 307 or equivalent. HUMPHREYS.

463. Research Methods in Clinical Psychology and Personality. The logical analysis of clinical inferences and their role in research; problems and methods in the investigation of the development, dynamics, and structure of personality; research in psychotherapy. ½ unit. Prerequisite: Psychology 306 and 403. BERNSTEIN, J. S. WIGGINS.

464. Social Perception. A review of method and theory in social perception, interpersonal attitudes, cultural influences on social perception, and theoretical analyses from the point of view of consistency theories, exchange, and status congruence theory. 1 unit. Prerequisite: Psychology 351 or equivalent. TRIANDIS.

465. Learning in Children. An examination of laboratory investigations of children's learning, with emphasis on developmental changes as related to current theories of learning and development. Class projects involve some laboratory work with children. 1 unit. Prerequisite: Twelve hours of psychology; consent of instructor. BOGARTZ, GOULET, WEIR.

467. Personality Assessment. Methods and theory in the quantitative assessment of personality; review of research findings and trends. 1 unit. Offered in 1970-1971 and in alternate years. Prerequisite: Psychology 307 or equivalent. J. S. WIGGINS.

468. Contemporary Behavior Theory. An introduction to modern attempts to formulate scientific theories of behavior, with special emphasis on theories concerning the learning

process, including the work of Hull, Tolman, and Guthrie. 1 unit. Prerequisite: Six units of graduate credit in psychology; consent of instructor. MAIER.

469. Cognitive Development. An examination of laboratory investigations of cognitive development in children, with emphasis on current theories of cognition and language. Class projects involve some laboratory work with children. 1 unit. Prerequisite: Twelve hours of psychology; consent of instructor. L. B. COHEN.

470. Principles and Methods of Teaching Psychology. Designed for graduate students in psychology. Among the major areas considered are: developing course objectives and content; developing and presenting teaching-learning situations; evaluating the attainment of course objectives; advising and counseling students; ethics in teaching; research problems on the teaching of psychology. ½ or 1 unit. Prerequisite: Second-year graduate standing in psychology or consent of instructor. COSTIN.

483. Psychology of Speech and Hearing Disorders, I. Same as Speech 483. A survey of psychological techniques utilized in the clinical and experimental study of speech and hearing disorders, with special reference to speech disorders. Review of research findings and development of experimental designs. 1 unit. Prerequisite: Consent of instructor. O'NEILL.

484. Psychology of Speech and Hearing Disorders, II. Same as Speech 484. A survey of psychological techniques utilized in the clinical and experimental study of speech and hearing disorders, with special reference to hearing disorders. Review of research findings and development of experimental designs. 1 unit. Prerequisite: Consent of instructor. O'NEILL.

485. The Sampling of Human Populations and Social Organizations. Same as Sociology and Business Administration 485. This course covers procedures for selecting samples from and estimating population parameters for human populations and social organizations. The types of sample designs treated include simple random samples—stratified and cluster samples together with random number and systematic selection techniques. Emphasis is given to the study of various kinds of advanced sample designs for both area and institutional settings together with the problems involved in the application of analytical statistics to complicated sampling procedures. Each student is required to participate in a field project which involves the actual selection of a cluster sample from the local area. 1 unit. Prerequisite: Sociology 387 or Economics 371, or consent of instructor.

490. Individual Research. For graduate students who wish to conduct research on special problems not included in graduate theses. ½ to 2 units. Prerequisite: Consent of instructor. STAFF.

492. Psychology of Learning and Instruction. Same as Educational Psychology 492. An advanced course in the nature and conditions of long-term cognitive learning and retention in classroom and similar situations. This course is intended for doctoral students with a special interest in research leading to the improvement of classroom teaching and learning, in psychological aspects of curriculum research, and in the cognitive aspects of military and industrial training. 1 unit. Prerequisite: Consent of instructor. ANDERSON.

493. Seminar. Discussion of current topics in their historical setting, with special emphasis on research problems. ½ or 1 unit. Prerequisite: Six units of graduate credit in psychology; consent of instructor. STAFF.

494. Multivariate Analysis in Psychology and Education. Same as Educational Psychology and Sociology 494. The principal methods of descriptive statistics used in the analysis of multiple measurements, with emphasis on conventional procedures of factor analysis; profile similarity models; discriminatory analysis; multidimensional scaling. 1 unit. Prerequisite: Psychology 307 or Educational Psychology 496; consent of instructor. TATSUOKA, TUCKER.

495. Theory of Measurement. Same as Educational Psychology 495. Logical and mathematical principles underlying test design, construction, and validation, with particular

emphasis on evaluating reliability of measurement, utility resulting from test-based decisions, and validity of descriptions of individuals. 1 unit. Prerequisite: Educational Psychology 496 or Psychology 307, or equivalent; Educational Psychology 392 or Psychology 390, or equivalent. TUCKER, WARDROP.

499. Thesis Research. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

306. Quantitative Methods, I. A lecture and laboratory course in the development and application of quantitative methods in psychological research. 1 unit. Prerequisite: Twelve hours of psychology, including Psychology 135 or equivalent. BATCHELDER, BOGARTZ, TATSUOKA.

307. Quantitative Methods, II. Continuation of Psychology 306. 1 unit. Prerequisite: Psychology 306. BATCHELDER, BOGARTZ, TATSUOKA.

311. Laboratory in Physiological Psychology. Research in classical and current problems, with emphasis on the nervous and endocrine systems in information processing and in the regulation of behavioral adaptation, with examples from sensation, perception, motivation, emotion, and learning. Laboratory. ½ or 1 unit. Prerequisite: Psychology 211; consent of instructor or academic counselor of the Department of Psychology. DONCHIN, GREENOUGH, MEAD.

323. The Small Social Group. Same as Sociology 323. Theory, observation, and analysis of face-to-face social groups, such as friendships, cliques, clubs, committees, and laboratory and experimental groups. Deals with the characteristics, functions, and forms of interaction of small groups and covers recent theoretical and empirical developments in this field of sociology. ½ or 1 unit. Prerequisite: Sociology or Psychology 201.

326. Motivation and Emotion. The nature and development of emotion, attitude, motive, and the role of these processes in social adjustment. ½ or 1 unit. Prerequisite: Six hours of psychology. J. B. COHEN.

330. Experimental Psychology, I. A survey of problems, experimental methods, and research findings in the fields of psychophysics, sensory processes, perception, judgment, and thinking. ½ unit. Prerequisite: Psychology 230 and 235; consent of instructor or academic counselor of the Department of Psychology. GREENBERG, HAKE.

331. Experimental Psychology, II. A survey of problems, experimental methods, and research findings in the fields of motivation, learning, retention, and work. ½ unit. Prerequisite: Psychology 235 and 248; consent of instructor or academic counselor of the Department of Psychology. MONTAGUE.

332. Research Methods in Social Psychology. Same as Sociology 332. A lecture and laboratory course in the methods and techniques of social psychological research. Emphasis is given to methods for laboratory experiments on small groups. ½ or 1 unit. Prerequisite: Psychology or Sociology 201; Psychology 235 or Sociology 184 and 185; consent of instructor or academic counselor of the Department of Psychology. DAVIS, FISHBEIN, MCGRATH.

335. Mathematical Formulations in Psychological Theory. Mathematical formulations are illustrated by studying quantitative treatments of various psychological processes. Emphasis is on learning theory, psychophysical laws, and other selected topics. Simple mathematical tools are developed as required. ½ or 1 unit. Prerequisite: Elementary statistics or probability, elementary calculus, and six hours of psychology, or consent of instructor. BATCHELDER.

338. Abnormal Psychology. An introduction for preprofessional students to the psychological aspects of the behavior disorders, including study of the insanities, psychoneuroses, mental deficiencies, and other conditions. ½ or 1 unit. Prerequisite: Six hours of psychology. BERNSTEIN, D. R. PETERSON, ULLMANN.

345. Comparative Psychology. Animal behavior with particular reference to the behavior

of vertebrates. ½ or 1 unit. Prerequisite: Six hours of psychology, or Psychology 100 or 103 and one course in zoology. HIRSCH, LIEBERMAN.

346. Behavior Genetics. Examination of the relations between genetic mechanisms, population structure, and individual differences in behavior; survey of research and possible extensions of research on the genetics of behavior; laboratory work on techniques of behavior study and genetic analysis. ½ or 1 unit. Prerequisite: Psychology 100, 103, or 105; a course in statistics; consent of instructor or academic counselor of the Department of Psychology. HIRSCH.

348. Theories of Learning. A survey of the basic theories and approaches to theory construction in learning. ½ or 1 unit. Prerequisite: Psychology 248 or Educational Psychology 211. BATCHELDER.

350. Research and Theory in Personality. The study of personality for the advanced student in psychology; the problems of measurement, development, structure, dynamics, and change of personality are considered; examples of current theory and research are studied as illustrations of an objective approach to the field. ½ or 1 unit. Prerequisite: Psychology 100 or 103; Psychology 235 or equivalent. CLORE.

351. Advanced Social Psychology. Same as Communications and Sociology 351. An integrative treatment of individual behavior variables in relation to group variables. ½ or 1 unit. Prerequisite: Psychology or Sociology 201; Psychology 235, or Sociology 385, or a comparable statistics course. MCGRATH, I. D. STEINER.

352. Attitude Theory and Measurement. Same as Communications and Sociology 352. A comprehensive survey of psychological theories of attitude organization and change, and a theoretical and methodological analysis of the various techniques used to measure attitude. Theories and methods are evaluated with respect to empirical research in the area. ½ or 1 unit. Prerequisite: Sociology or Psychology 201; a course in statistics. FISHBEIN.

355. Industrial Social Psychology. Same as Labor and Industrial Relations 355. Social psychological research and theory applied to industrial problems. Emphasis upon interaction and communication theory, role theory, leadership theory, motivational and perceptual theory, and group structure theory as an aid in understanding and analyzing industrial problems. ½ or 1 unit. Prerequisite: Psychology 201 or 357. TRIANDIS.

356. Human Factors in Equipment Design. The contributions of psychological research to the design of equipment for efficient human use and operation. Studies of the characteristics and limitations of the human individual which bear upon the equipment and machines best suited to his use. A survey of research on visual and auditory displays, controls, layout of consoles; complex man-machine systems; vigilance and isolation effects; design for efficient trouble-shooting and maintenance. Emphasis is placed upon the methods used in collecting data on these problems. Applications to engineering, industrial design, management, etc., are discussed. ½ or 1 unit. Prerequisite: Psychology 100 or 103; one course in statistics or college mathematics. WILLIGES.

357. Psychology of Industrial Conflict. Same as Labor and Industrial Relations 357. An analysis, in terms of behavior of individuals, of the causes and possible solutions of industrial conflict. No credit is given for undergraduate majors in psychology. ½ or 1 unit. Prerequisite: Psychology 100 or equivalent. Offered in special interest of industrial relations, commerce, and engineering students. HULIN.

359. The Social Psychology of Organization. Same as Sociology 359. Analysis of the interrelationships between social and psychological factors on the one hand and organizational structure and process on the other; emphasis on sources, consequences, and modes of resolution of intra-individual, intra-organizational, and inter-organizational conflict. 1 unit. Prerequisite: Psychology 355 or Sociology 322. MCGRATH.

360. Modern Viewpoints in Psychology. A brief survey of early theoretical psychology followed by an examination of contemporary "behavior theory," Gestalt theory, and

psychoanalytic theory—as conceptions of man and and as approaches to the study of learning, perception, personality, and social behavior. ½ or 1 unit. Prerequisite: Nine hours of psychology with an average grade of B, or consent of instructor. DULANY.

361. Advanced Developmental Psychology. Theory and research on psychological development from birth through adolescence; maturation of behavior systems; the role of social learning in development; the effects of early experience on personality development; critical stages in development. ½ to 1 unit. Prerequisite: Psychology 216 or 217; a course in statistics. L. B. COHEN, SCOTT.

369. Introduction to Human Ecology. Same as Anthropology, Geography, Health Education, Physiology, Sociology, Veterinary Medical Science, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations, and physiological, psychological, and sociological adjustments to environment, regulation of populations, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology; one year of anthropology, geography, geology, or sociology. SHIMKIN, STAFF.

371. Psychological Factors in Political Behavior. An application of psychological methods and theories to the study of political behavior. Special attention is given to research methods and to content problems in voting behavior and national security policy. ½ to 1 unit. Prerequisite: Six hours beyond 100-level courses in psychology, political science, or sociology. FISHBEIN.

373. Human Development in Cross-Cultural Perspective. Same as Anthropology 373. The comparative analysis of recurrent problems inherent in the biosocial nature of man, particularly as these are reflected in stages of the life cycle from birth through death. Attention is also given to the cross-cultural study of other selected topics such as illness and health, deviancy, and the handling of aggression. Use is made of materials available on the campus in the Human Relations Area Files. ½ or 1 unit. Prerequisite: Six hours of anthropology, psychology, or sociology, or consent of instructor. MALPASS.

374. Problems in Human Ecology. Same as Anthropology, Geography, Health Education, Physiology, Sociology, and Veterinary Medical Science 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multidisciplinary studies of selected current problems. 1 unit. Prerequisite: Anthropology, Geography, Health Education, Physiology, Sociology, or Zoology 369.

386. Methods of Field Research. Same as Sociology 386. Instruction, training, and supervised practice in methods of field research as a basic tool of psychology. Major emphasis is placed on the role of the field researcher as participant, observer, and interviewer in various kinds of research settings, and on approaches to and applications of field data. Each student develops and executes a field research project dealing with some aspect of institutional, occupation, or general community activity and structure. ½ or 1 unit. Prerequisite: Psychology or Sociology 201; Psychology 235 or Sociology 184 and 185.

390. Psychological Tests and Measurements. The measurement of human behavior in psychological studies; the construction and use of psychological tests; introduction to tests of intelligence, achievement, personality, and interest; practice in test construction, administration, and validation. Lectures and laboratory. 1 unit. Prerequisite: Psychology 235. HULIN, N. A. WIGGINS.

RADIO AND TELEVISION

The Department of Radio and Television offers work leading to the Master of Science in Radio and Television. For the program leading to the Doctor of Philosophy in Communications, see page 138.

Admission to the program leading to the Master of Science requires (1) completion of the requirements for a bachelor's degree in an institution of recognized standing, preferably with

a major (normally twenty semester hours) in radio-television or a related field, English, or the social sciences; (2) a grade-point average of at least 4.0. Applications of students with grade-point averages below 4.0 but above 3.5 are considered on an individual basis.

Requirements for the degree of Master of Science in Radio and Television include: (1) A major of four units or three units and one additional unit approved by the adviser; (2) a minor of at least two units, normally in an area outside the College of Communications; (3) a one-unit thesis or an approved production project; (4) a minimum of three units in courses (including thesis) at the 400 level, at least two of which must be in the major field; (5) a minimum of eight units.

A list of the specific courses that must be included in the Master of Science in Radio and Television degree program is available upon request from the department.

FACULTY

Professor: F. E. Schooley.
Assistant Professors: J. E. Cramer, E. F. Douglass, H. W. Lippold, Jr., D. P. Mullally.

COURSES FOR GRADUATES

450. Special Problems in Television. Project work for advanced students in specific areas of television, including news, advertising, directing, writing, etc. ½ to 3 units; a maximum of 3 units is permitted toward degree. Prerequisite: A television course in the area of specialization; consent of instructor. Staff.

451. Television Program Management and Production. Problems in originating, planning, and producing television programs. 1 unit. Prerequisite: Course or experience in television directing and production; consent of instructor.

462. Seminar in Radio and Television. Same as Communications 462. A study of the performance of radio and television in terms of content, government and industry controls, social responsibility, economic bases, and psychological and social effects. 1 unit.

463. World Broadcasting. Same as Communications 463. A study of the broadcast systems used by the nations of the world; alternative and "mixed" systems; international organizations, agreements, exchanges, and problems; broadcasts to and from other countries; implications of such new developments as satellites; mass and non-mass uses. 1 unit. Prerequisite: Radio and Television 462 or consent of instructor.

490. Special Topics in Radio and Television. ½ or 1 unit. Prerequisite: Consent of head of department. Staff.

499. Thesis Research. 1 to 2 units. Prerequisite: Graduate standing in radio and television. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

354. Television Directing. The theory and techniques of directing the television program. Experience in directing laboratory productions. ½ unit. Prerequisite: Radio and Television 252; consent of head of department.

355. Television News. News coverage, script preparation, use of visual materials, and presentation of news programs. Attention given to interviews, special events, and news fields of special interest. ½ unit. Prerequisite: Consent of instructor. Lippold.

356. Cinematography for Television. The equipment and techniques used in the production of films for television, including camera operation, lighting, editing, sound recording, matching, etc. Materials cost approximately $50.00. ½ unit. Prerequisite: Consent of instructor.

357. Broadcast Continuity Writing. A study of the fundamentals of radio and television continuity writing, including commercial copy, talks, interviews, music, and feature programs. ½ unit. Prerequisite: Consent of instructor.

360. Educational Uses of Television and Radio. Same as Communications and Educational Psychology 360. A study of television and radio as educational instruments, and standards necessary for such use; production, utilization, planning, and evaluation; primary and secondary uses. Identification of the unique contributions and resources of the electronic media, as well as their limitations. Experimentation into new production and utilization techniques designed for educational uses. ½ unit.

362. Radio and Television Station Management. A study of the organization and administration of the radio and television staff and station; public relations, personnel management, and station operation; analysis of station and agency relationships and radio and television sales procedure; methods and media for program and station promotion; laws and regulations affecting management, financing, and labor relationships. ½ unit. Prerequisite: Radio and Television 261.

363. Advanced Dramatic Writing. Same as Speech and English 363 and Theatre 380. Application of principles of dramatic form and structure to the more complex problems of playwriting. Practice in writing sustained dramatic forms. ½ or 1 unit; students may accumulate 2 units of credit. Prerequisite: Speech 263 or equivalent; consent of instructor.

365. Radio News. News writing and editing for broadcasting; radio news style; preparation and practice for special event reporting; commentaries and interpretations; radio news services, and processing radio news service copy. ½ unit. Prerequisite: Journalism 211. CRAMER.

366. Advanced Radio and Television Practices, I. Project work for advanced students in selected areas of radio and television, including news, advertising, announcing, production and direction, and writing. ½ unit. Prerequisite: All courses in area of specialization; consent of instructor. STAFF.

367. Advanced Radio and Television Practices, II. Continuation of Radio and Television 366. ½ unit. Prerequisite: All courses in area of specialization; consent of instuctor. STAFF.

368. Radio and Television Regulation. Federal legislation, with emphasis on the Communications Act of 1934 and the regulations of the Federal Communications Commission, legal problems in program operation, censorship and editorial selections, copyright, and author-producer relations. ½ unit.

RECREATION AND PARK ADMINISTRATION

The Department of Recreation and Park Administration offers a program of graduate study leading to the Master of Science in Recreation. (For information regarding the degree of Philosophy in Physical Education with specialization in recreation, see page 322.) This program primarily prepares supervisors, administrators, teachers, and research workers in community recreation, but it also offers opportunities for preparation in the related fields of park administration, therapeutic recreation and rehabilitation, outdoor recreation, and college union administration, as well as recreation work with private agencies, business and industry, commercial recreation enterprise, etc.

Admission requirements for a major in this field are (1) a minimum grade-point average of 3.5 for the last sixty semester hours; (2) thirty semester hours of approved undergraduate credit in recreation or closely allied courses; (3) fifteen semester hours in the social and psychological sciences; (4) eight semester hours of undergraduate credit in the natural sciences; and (5) a course in statistics or tests and measurements.

Requirements for this degree are eight units including: (1) four units in recreation or approved courses; (2) two units of approved electives; (3) registration in and satisfactory completion of Recreation 490; and (4) thesis, two units. The thesis requirement may be waived upon approval of a petition, but the student must substitute two additional units of course work and pass a comprehensive examination.

FACULTY

Professor: A. V. Sapora (Head of Department).
Associate Professor: H. E. Weaver.
Assistant Professors: D. W. Bishop, J. M. Ellis, M. Virginia Frye, A. F. Gramza, D. M. Landers, G. A. Lowrey, Jr., R. Martens.

COURSES FOR GRADUATES

401. Foundations of Recreation. Basic philosophical, historical, and scientific foundations and developments in leisure and recreation; analysis of recreation values as related to other contemporary individual and community needs; functions and settings of organized recreation, special problem areas, and current issues. 1 unit. Prerequisite: Recreation 100 or equivalent. Sapora.

402. Recreation Administration. Designed to strengthen the graduate student's knowledge of the public administration of recreation programs and services provided by municipal, county, state, and national departments and agencies and as related to the general well-being of individuals, families, and communities. 1 unit. Prerequisite: Basic courses in the organization of recreation, or equivalent. Bannon, Lowrey.

403. Evaluation of Recreation Resources and Programs. Methods and techniques of determining recreational needs, interests, and opportunities of individuals and communities through surveys, studies, and appraisals; evaluating and appraising community recreation programs and services; research in the field of recreation. 1 unit. Prerequisite: Recreation 100 or 310, or equivalent. Bishop.

404. Outdoor Education and Recreation. Philosophy, essential principles, methods, techniques, resources, administrative and program practices for outdoor education and recreation. 1 unit. Prerequisite: Recreation 140 or equivalent; one undergraduate course in any one of the following: biology, botany, geology, or zoology. Weaver.

490. Seminar. Student presentation of thesis studies, informal discussions, and critical analysis of problems; informal lectures by invited speakers. 0 credit. Staff.

493. Special Projects. Independent research on special projects. Open only to students majoring in recreation. ½ to 2 units. Prerequisite: Recreation 403 or equivalent. Staff.

499. Thesis Research. Preparation of thesis in recreation. 0 to 4 units. Staff.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

310. Introduction to Administration. Organization of public and private agency programs, leadership, facilities and services; introduction to recreation administration. ½ or 1 unit. Prerequisite: Recreation 100. Pezoldt.

320. Park Management. An intensive study of the principles, practices, and problems involved in managing public park systems. Designed to provide a professional background including the history of parks, organization, planning, examination of facility design and layout, maintenance, finance, and operation of park systems. ½ or 1 unit. Prerequisite: Open to senior recreation majors, or to others with consent of instructor; the following recreation courses or equivalent must be completed: Landscape Architecture 226, Urban Planning 171, Political Science 305, Recreation 280 and 281. Van Meter.

321. Recreational Use of Public Lands. A study of lands in the public domain, and their historical, current, and potential use for outdoor recreation. It includes an analysis of land, woods, and water in the public domain; the demand for outdoor recreation; multiple use concept of natural resources; functions and policies of federal and state governments and their agencies; the economics of outdoor recreation; and the future of outdoor recreation in America. ½ or 1 unit. Prerequisite: Recreation 100, Geography 214, and Economics 108, or consent of instructor. Van Meter.

330. Principles of Therapeutic Recreation. Concepts, principles, objectives, methods, and settings of recreation for the ill and handicapped. ½ or 1 unit. Prerequisite: Recreation 100 and 180 or 181, or consent of instructor. Frye.

RUSSIAN LANGUAGE AND AREA STUDIES

Graduate programs in Russian language and area studies are offered by the Russian and East European Center in cooperation with various departments.

Minor for the Master's Degree. A candidate for the master's degree who elects Russian language and area studies as a minor must earn at least two units of graduate credit in courses chosen from the following: anthropology, economics, geography, history, law, library science, political science, Russian, and sociology. The courses chosen must be in at least two departments.

Minor for the Doctor of Philosophy Degree. A doctoral candidate who elects Russian language and area studies as a minor must demonstrate a reading command of Russian as tested by examination or by completion of Russian 104 or 401 with a grade of A or B, and in addition must earn at least four units of graduate credit in courses chosen from the list given just above. The four units must include courses from at least two departments outside of, and may at the same time include up to one unit from within, the department offering the candidate's major.

Certificate of Graduate Specialization in Russian Language and Area Studies. This certificate is awarded by the Graduate College and the Russian and East European Center. It is for persons with the baccalaureate who are enrolled in advanced studies in any discipline and who wish at the same time to gain a knowledge of the Russian area and language. The requirements are: (1) A good command of written and spoken Russian, as determined by special examinations, or a grade of A or B in Russian 104 or 401. (2) At least six graduate units relating to Russia, distributed among at least three of the departments represented in the program (anthropology, economics, geography, history, law, library science, political science, Russian, and sociology) other than the student's own major department. If the student's major department is one of these nine he may count, as part of his six units, up to one unit from within his major department. (3) A special essay based largely on Russian sources, which must meet, at the minimum, the standard normally required in a master's thesis. The student may submit, in fullfillment of this requirement, a copy of his master's thesis or doctoral dissertation.

The adviser for the graduate minors and the Certificate is Professor Ralph T. Fisher Jr., Director of the Russian and East European Center, 1207 West Oregon Street, Urbana.

FACULTY

Professors: R. T. Fisher Jr. (Director of Russian and East European Center), C. L. Dawson, E. J. DeMaris, F. Dovring, J. D. Fellmann, K. A. Hitchins, D. R. Hodgman, E. G. Lewis, P. B. Maggs, J. A. Nichols, Temira Pachmuss, P. W. Schroeder, D. B. Shimkin, A. Vucinich.

Associate Professors: Evelyn Bristol, F. M. Gottheil, S. P. Hill, K. Klein, L. H. Miller, R. F. Miller.

Assistant Professors: M. A. Curran, R. Dunatov, F. Y. Gladney, J. P. McKay, J. R. Millar, D. L. Ransel, B. P. Uroff.

SLAVIC LANGUAGES AND LITERATURES

(Including Czech, Russian, Slavic, and Ukrainian)

The Department of Slavic Languages and Literatures offers graduate work leading to the Master of Arts in Russian, Master of Arts in the Teaching of Russian, and Doctor of Philosophy in Russian literature or Slavic linguistics.

Students with a grade-point average of 4.0 or above are regularly admitted to graduate courses, subject to fulfillment of other prerequisites. Students with a grade-point average between 3.75 and 3.99 may be admitted upon approval of the department, subject to quota limitations.

Students electing Russian as a major subject should have had the equivalent of at least four years of Russian in college, including practical work in the use of the language and some advanced course work in Russian literature.

Students choosing Russian as a minor subject should consult the department.

Master of Arts in Russian. In addition to fulfilling the general requirements of the Graduate College, candidates must pass both a written and an oral examination. Students may major in literature or linguistics. Students majoring in literature must present at least two courses in linguistics; those majoring in linguistics must present at least two courses in literature.

Master of Arts in the Teaching of Russian. All candidates for this degree are required to take: (1) Russian, five units: up to three units from 300-level courses and at least two units from courses open only to graduates; (2) education, two units including Educational Psychology 311 and 312 and two of the following: History and Philosophy of Education 303, 304, 305; (3) electives, one unit. These courses must be selected with the approval of the adviser. Candidates must pass an examination based on their course work and on a reading list. See pages 36 and 37.

Doctor of Philosophy in Russian. All candidates for this degree must fulfill the general requirements of the Graduate College and must have a reading knowledge of French and German. A student may major in literature or linguistics, and may offer a minor, preferably in another language or literature, comparative literature, or linguistics. Those students majoring in literature must present at least four courses in linguistics, as well as training in another Slavic language; students majoring in linguistics must present at least four courses in literature, along with some training in two other Slavic languages.

FACULTY

Professors: C. L. Dawson (Head of Department), Temira Pachmuss.
Associate Professors: Evelyn Bristol, F. Y. Gladney, S. P. Hill, K. Klein.
Assistant Professors: M. A. Curran, R. Dunatov.

Czech

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

383. The Structure of Modern Czech. Analysis of the sound system and grammar of the contemporary Czech language with some reference to its historical development. $^3/_4$ unit. Prerequisite: Knowledge of another Slavic language, preferably Russian, or consent of department.

384. Readings in Czech Literature. Representative works of modern Czech literature and their historical and cultural background. $^3/_4$ unit. Prerequisite: Czech 383 or consent of department.

Russian

The following courses are regularly taught in Russian: Russian 415, 419, 420, 422, 424, 303, 304, 308, 313, 314, 321, 322, 323, 324, 325, and 326.

COURSES FOR GRADUATES

400. Beginning Russian for Graduate Students. Basic grammar and vocabulary, introduction to the reading of Russian texts in the sciences and the humanities. Designed for graduate students preparing to offer a reading knowledge of Russian for the Ph.D. 4 semester hours. No graduate credit.

401. Readings in Russian for Graduate Students. Reading and translation of general

and individually specialized materials, to increase speed, accuracy, and vocabulary. Designed for graduate students preparing to offer a reading knowledge of Russian for the Ph.D. 4 semester hours. No graduate credit. Prerequisite: Russian 400 or equivalent.

406. Russian Morphology. A survey of the various parts of speech of modern standard literary Russian with special emphasis on the nominal and verbal systems. 1 unit.

407. Russian Syntax. A survey of historical and contemporary Russian syntax. 1 unit. Prerequisite: Consent of instructor or head of department.

408. Russian Phonology. Same as Linguistics 408. Synchronic examination of the phonological system of modern Russian and of its interrelation with the syntactic and lexical systems; brief discussion of the historical development of the phonological system. 1 unit. Prerequisite: Consent of instructor.

410. Old Russian Literature. Reading and analysis of texts with historical and literary commentary. 1 unit. Prerequisite: Slavic 405 or Russian 417.

412. Literature of the Eighteenth Century. Reading of texts. Historical and literary background of the period. 1 unit.

414. Pushkin. The age of Pushkin; Pushkin's works in historical and comparative perspective; textual criticism, linguistic and structural analysis, intellectual interpretation, and aesthetic evaluation. 1 unit. Prerequisite: Consent of instructor or head of department.

415. Dostoevsky. Dostoevsky: historical background, textual analysis, structure, philosophy and ideology, and aesthetic evaluation. 1 unit. Prerequisite: Consent of instructor or head of department.

416. Studies in Russian Criticism. 1 unit. Prerequisite: Consent of instructor or head of department.

417. History of the Russian Language. 1 unit. Prerequisite: Slavic 405.

419. Tolstoy. Tolstoy: historical background, textual analysis, structure, philosophy and ideology, and aesthetic evaluation. 1 unit. Prerequisite: Consent of instructor or head of department.

420. Chekhov. Chekhov: historical background, textual criticism, structural analysis, philosophy and ideology, and aesthetic evaluation. 1 unit. Prerequisite: Consent of instructor or head of department.

421. Seminar in the Russian Novel. Dostoevsky, Tolstoy, nineteenth-century novel, twentieth-century novel. 1 unit. May be repeated for a total of 3 units. Prerequisite: Consent of instructor or head of department.

422. Russian Literature in Exile. Bunin, Merezhkovsky, Kuprin, Zaitsev, Remizov, Teffi, Aldanov, Shmelev, Z. Hippius, V. Ivanov, Khodasevich, Tsvetaeva, Varshavsky, Odoevtseva, G. Ivanov, Adamovich—prose writers, poets, and critics. 1 unit.

423. Seminar in Russian Poetry. Pushkin, narrative verse, lyric verse, symbolism. Course may be repeated for credit not to exceed 3 units. 1 unit. Prerequisite: Russian 337 or consent of department.

424. Gogol. Historical background, textual criticism, structural analysis, philosophy and ideology, and aesthetic evaluation. 1 unit. Prerequisite: Consent of instructor or head of department.

425. Seminar in Russian Drama. Intensive analysis and discussion of specific genres, periods, and dramatists in the light of dramatic theories. The subject of the course varies each year. 1 unit. May be repeated for a maximum of 3 units. Prerequisite: Russian 335 or consent of department.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

303. Advanced Reading and Conversation, I. Practice in conversation with a native speaker, based on reading materials from Russian literature and culture. ½ unit. Prerequisite: Three years of college-level Russian.

304. Advanced Reading and Conversation, II. Practice in conversation with a native speaker, based on reading materials from Russian literature and culture. ½ unit. Prerequisite: Russian 303 or equivalent.

307. Structure of Russian. The morphology, syntax, and lexicon of modern Russian, contrasted with English, with attention to problems of teaching. ¾ unit. Prerequisite: Russian 214 or consent of instructor.

308. Russian Phonetics and Pronunciation. Study of the Russian sound system; training in the improvement of pronunciation and intonation. ¾ unit. Prerequisite: Russian 212 or consent of instructor.

313. Advanced Composition and Usage, I. Practice in advanced composition and study of advanced problems of grammatical structure with emphasis on morphological categories in Russian grammar. ¾ unit. Prerequisite: Three years of college Russian including Russian 213 and 214, or consent of department.

314. Advanced Composition and Usage, II. Further practice in advanced composition and study of advanced problems of grammatical structure with emphasis on syntax, usage, and style. ¾ unit. Prerequisite: Russian 313 or consent of department.

317. Soviet Literature in Translation. Survey of Russian literature since the 1917 Revolution; cultural and historical background of the period. No knowledge of the Russian language is required. ¾ unit. Prerequisite: Junior standing or consent of instructor.

321. Russian Literature from 1810 to 1845. Representative works of the period, with emphasis on Pushkin, Lermontov, and Gogol. ¾ unit. Prerequisite: Russian 216 or consent of instructor.

322. Dostoevsky and Tolstoy. Representative works in their historical and cultural contexts. ¾ unit. Prerequisite: Russian 216 or consent of instructor.

323. Russian Literature from 1845 to 1880. Representative works of the period, with emphasis on Turgenev, Goncharov. ¾ unit. Prerequisite: Russian 216 or consent of instructor.

324. Russian Literature from 1880 to 1917. Representative works of the period, with emphasis on Chekhov, Gorky, and Blok. ¾ unit. Prerequisite: Russian 216 or consent of instructor.

325. Soviet Russian Literature. Representative works of Russian literature since 1917; Mayakovsky, Leonov, Sholokhov, and others; historical and cultural backgrounds. ¾ unit. Prerequisite: Russian, 215, 216, 217, or consent of instructor.

326. Masterpieces of Russian Literature. Masterpieces of Russian literature: historic background, textual analysis, structure, philosophy and ideology, aesthetic evaluation. ¾ unit. Prerequisite: Russian 216 or consent of instructor.

332. Traditions of Russian Literature and Thought. The rise and development of Russian social and philosophical thought in the nineteenth century and its impact on literature. ¾ unit. Prerequisite: Consent of instructor.

333. The Russian Short Novel. Theory and techniques of the *povest'* and related forms in the nineteenth and twentieth centuries. ½ unit. Prerequisite: Russian 216 or consent of instructor.

335. Russian Drama. Historical survey of Russian dramatists and their works: from the origins in folk and liturgical playlets, through classicism, Gogol, Ostrovsky, Chekhov, and Stanislavsky, to Meierhold and the Soviet drama. 1 unit. Prerequisite: Russian 216 or equivalent.

337. Russian Poetry. A study of significant Russian poets and their works from Zhukovsky through the twentieth century. 1 unit. Prerequisite: Russian 216 or equivalent.

Slavic

COURSES FOR GRADUATES

405. Old Church Slavonic. Analysis of grammar, reading of texts, discussion of development of the Slavic languages. 1 unit. Prerequisite: Slavic 380.

418. Oral Poetry and Slavic Poetics. Linguistic material and poetic form. Oral poetry in its genres, motifs, and themes; their unit and diversity in the cultural history of Slavic peoples; the impact of oral poetry on literary tradition. 1 unit.

460. Comparative Slavic Phonology. The phonological structure of Common Slavic at the time of dissolution of the primitive Slavic community; the characteristic tendencies in the evolution of sound and prosodic systems in the East, West, and South Slavic language groups; the phonemic patterns of single modern Slavic languages outlined as a basis for a typological classification of Slavic languages. 1 unit. Prerequisite: Slavic 380.

461. Comparative Slavic Morphology. A lecture course designed to trace the development of the principal parts of speech, their various inflectional and derivational morphemes and their attendant grammatical categories from Common Slavic to the various modern Slavic languages, and to make comparisons among the modern synchronic morphological treatments of these languages. 1 unit. Prerequisite: Slavic 460.

491. Individual Topics. $\frac{1}{4}$ to 2 units. Prerequisite: Graduate standing with a major or minor in Russian.

499. Thesis Research. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

331. Slavic Civilization and Literatures. A survey of Slavic institutions and life as reflected in Slavic literatures other than Russian (Polish, Czech, Ukrainian, etc.) and their connection with Russian traditions. $\frac{3}{4}$ unit. Prerequisite: Reading knowledge of Russian or one other Slavic language, or consent of instructor.

380. Introduction to Slavic Linguistics. Same as Linguistics 380. Changes in phonology and morphology from Indo-European to Common Slavic; geographical distribution of Slavic languages and dialects, prehistory and early history of the Slavs, and Balto-Slavic linguistic relationships. $\frac{3}{4}$ unit. Prerequisite: Reading knowledge of at least one Slavic language.

382. Language Laboratory Techniques. Same as French, German, and Spanish 382. Instruction and practice in the techniques of making foreign-language tapes and integrating them with classroom activity; instruction in the problems of planning and operating a language laboratory. $\frac{1}{2}$ unit. Prerequisite: Three years of a modern foreign language at the college level, or equivalent.

394. Introduction to Folkore: History, Theory, Methods. Same as Comparative Literature, English, and German 394, and Speech 346. An introduction to the study of folklore with emphasis on folk cultures in the Old and New World; an historical survey of the development of folklore study, an analysis of the methods and genres of folklore, and an introduction to field collecting and evaluation of archival materials. $\frac{3}{4}$ unit. Prerequisite: A reading knowledge of one modern foreign language is recommended.

Ukrainian

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

396. The Structure of Ukrainian. Ukrainian phonology, morphology, and syntax presented with Russian as a background and basis for comparison of these two East Slavic languages. $\frac{3}{4}$ unit. Prerequisite: Russian 104 or equivalent.

398. Readings in Ukrainian Literature. Representative works of Ukrainian literature and their historical and cultural background. ¾ unit. Prerequisite: Ukrainian 396 or consent of instructor.

SOCIAL SCIENCES

Master of Arts in the Social Sciences. A special program leading to the Master of Arts in the Social Sciences is offered to students through the Division of Social Sciences (including anthropology, economics, geography, history, philosophy, political science, psychology, social work, and sociology). This program is designed to meet the needs of students who plan to teach the social sciences and the needs of those who wish to study in several related fields within the social sciences rather than to specialize in one department. To qualify for this program a student must have a grade-point average of at least 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

The Master of Arts in the Social Sciences requires a major of four units and a minor or double minor totaling four units. No minor may be less than two units. At least three of the eight units required for this degree must be in 400-level courses, with at least two of these three units in the major. The student's work is directly supervised by an advisory committee, composed of two or three members, one for each field of study forming a major or minor. The representative of the major field is the chairman of the committee. As part of his work in the major field, each student is required to write an essay under the direction of the chairman of the committee and subject to his approval. Work upon this essay may constitute, through registration in research courses, part of the four units of work required for the major. At the completion of his studies the student must pass an oral comprehensive examination given by the committee as a whole.

The Chairman of the Division of Social Sciences is Professor Clark C. Spence, 359 Armory. The general adviser for this degree is Professor Alfred W. Booth, 223 Davenport Hall.

Master of Arts in the Teaching of Social Studies. Candidates for this degree who hold secondary school social studies certificates may complete requirements with eight units of graduate work. Four units are to be in the social studies (two of these must be in history); three units are in advanced education (Educational Psychology 311 and 312, History and Philosophy of Education 304 and 305, and Secondary and Continuing Education 456); and one unit is an elective chosen in consultation with the adviser.

Potential candidates who are not certified may be admitted with deficiencies. Such individuals must satisfy the requirements for an Illinois secondary school social studies certificate as well as the general degree requirements outlined above.

The grade-point average required for admission is 3.75. Applications of students with grade-point averages below 3.75 but above 3.5 are considered on an individual basis. See pages 36 and 37.

Additional information may be obtained from the adviser for this degree, Professor Robert A. Waller, 315 Armory.

SOCIAL WORK

The Jane Addams Graduate School of Social Work offers a complete program of professional study leading to the degree of Master of Social Work. Similar programs are offered on both the Chicago Circle campus and the Urbana-Champaign campus of the University. Social Work career concentrations are provided in the following three areas: social and direct treatment which includes casework and group work, community organization and community planning, and social policy and administration. On the Urbana-Champaign campus, the curriculum may be completed in sixteen months of continuous full-time study. At Chicago Circle, the curriculum may be completed in two academic years of study. Field instruction from the Chicago Circle campus is centered in Chicago and suburban social agencies.

On the Urbana-Champaign campus, field instruction is conducted through social agencies located in Urbana-Champaign, Decatur, Danville, Peoria, and Springfield.

A special catalog is issued by the School which describes in detail the programs offered on both the Chicago Circle campus and the Urbana-Champaign campus. This catalog may be obtained by writing to the Director, Jane Addams Graduate School of Social Work, University of Illinois at Urbana-Champaign, 1207 West Oregon Street, Urbana, Illinois 61801. The courses listed on pages 361 to 364 are those offered on the Urbana-Champaign campus. The School's special catalog should be consulted for the Chicago Circle program. Application for admission must be made to the Jane Addams Graduate School of Social Work.

The School has established an admissions committee which is responsible for reviewing all applications. The committee's scrutiny of scholastic achievement is directed principally to the applicant's record in the social sciences and preprofessional social work courses, and in those courses which reveal mastery of the English language. A minimum of twenty hours in social science courses is required. The applicant must give evidence of ability to carry graduate work.

In addition to scholastic achievement, the admissions committee attempts to determine the applicant's personal suitability for professional education in social work. Admission is granted only to the applicant whose health is sufficiently good to permit his undertaking a study program which taxes physical energy. The applicant must also show evidence of emotional maturity commensurate with his age and past experience; interest in and liking for people; an ability to establish effective and healthful relationships; and personal integrity as demonstrated by intellectual honesty and a sense of responsibility. Serious deficiencies in these areas disqualify an applicant.

FACULTY

Professors: M. P. Hale (Director of the Jane Addams Graduate School of Social Work), F. H. Itzin, D. E. Lathrope, M. A. Taber.

Associate Professors: R. J. Anderson (Assistant Director), Lela B. Costin, M. Elizabeth Edwards, C. H. Henderson, J. E. McDonald, Marjorie McQueen, A. E. Vattano.

Assistant Professors: Sonya M. Clay, R. A. Downing, G. L. Euster, Ketayun H. Gould, E. N. Gullerud, Mildred S. Johnson, Bok-Lim C. Kim, P. L. Leuenberger, Shirley H. Wattenberg.

COURSES FOR GRADUATES

420. Comparative Approaches in Community Organization Practice. Concepts and theories, principles and methods characterizing identifiable approaches used in community organization practice at neighborhood, community, state, and other levels. ½ to 2 units. Prerequisite: Credit or registration in Social Work 421, or consent of instructor.

421. Principles of Social Work Treatment. Components of social work treatment with clients; analysis of social work values, methods, use of professional self, treatment procedures of change; theory and problem assessment; development and implications of social work goals. ½ to 1 ½ units.

422. Social Casework, II. Casework principles and methods with emphasis on work with clients with complex emotional and personality problems; the stresses which impair social and ego functioning; the effects of agency setting. Casework methods as adapted to treatment of children and their parents, adults, the neurotic and mentally ill, the delinquent; multiple client interviewing and family diagnosis and treatment. ½ to 1 unit. Prerequisite: Social Work 421.

423. Comparative Approaches to Social Group Work Practice. Study of practice theory in social group work through a comparative study of various identifiable practice approaches. ½ to 1½ units. Prerequisite: Social Work 421 and 425, or consent of instructor.

425. Group Process and Method. Small group theory and the group process; the use of group process and methods in social work practice. ½ to 1 unit.

426. Social Planning and Administration. Principles, concepts, and methods of planning and administration of social services; emphasis on leadership, policy and decision making, and program organization. $\frac{1}{2}$ to 1 unit.

427. Social Research. Objectives of social research, design of experiments, and measurement and methods of collecting data; design of questionnaires and schedules; methods of data analysis including statistical hypothesis testing and applications of inferential techniques; interpretation of results; preparation of reports. $\frac{1}{2}$ to 1 unit.

428. Seminar on a Comparative Analysis of Selected Models of Family Therapy. Critical examination of the principles, issues, and practice of family therapy. Application of concepts to observation of actual family therapy conducted by students and/or the instructor. The process of developing a model for practice. $\frac{1}{2}$ to $1\frac{1}{2}$ units. Prerequisite: Social Work 421; consent of instructor.

429. Seminar in Methods of Intervention with Low-Income Families. Analysis of distinguishing characteristics and social problems of low-income populations; critical review of issues regarding social work interventive methods utilized in the past and at present. Emphasis is placed on analysis, construction, and evaluation of significant practice principles with a view toward innovation. $\frac{1}{2}$ to $1\frac{1}{2}$ units. Prerequisite: Social Work 421 or equivalent.

431. Practice Seminar, I. Critical examination of the application of knowledge to social work practice; emphasis on reciprocal relationships between personal problems and needs, social environment, agency services, and helping methods; consideration of new trends in practice and empirical knowledge. 1 unit. Prerequisite: Consent of instructor.

432. Practice Seminar, II. Critical examination of the application of knowledge to social work practice; emphasis on relationships between personal problems, social problems, planning processes, and agency purposes and functions; consideration of trends in social policy and empirical knowledge. 1 unit. Prerequisite: Consent of instructor.

451. Human Growth and Behavior, I. The major forces influencing the growth and behavior of the individual from birth through adulthood; sociocultural, familial, physical, emotional, and intellectual factors as they enhance or retard social functioning; the nature and dynamics of social process as related to growth and behavior; the relevance of this content to social work practice, $\frac{1}{2}$ to 1 unit.

452. Human Growth and Behavior, II. Inter-relationship of physical, emotional, and social aspects of selected diseases, and implications for the patient, family, and community; psychopathology, including neuroses, psychoses, character disorders, psychosomatic dysfunction, organic conditions, and mental retardation; diagnosis and treatment methods, including psychotherapy, somatic and drug therapies, and social work. $\frac{1}{2}$ to $1\frac{1}{2}$ units. Prerequisite: Social Work 451.

461. Special Studies in Social Work, I. Independent or group study in areas of special interest; application of social work principles to special problems or settings. $\frac{1}{2}$ to 2 units.

462. Special Studies in Social Work, II. Independent or group study in areas of special interest; application of social work principles to special problems or settings. $\frac{1}{2}$ to 2 units.

466. Field Instruction, I. The student is assigned to field instructors for learning experiences in social agencies and communities. Such experiences include the use of knowledge and understanding in analyses of case and problem situations and in direct service to agency clientele. $\frac{1}{2}$ to 1 unit. Prerequisite: Consent of instructor.

467. Field Instruction, II. The student is assigned to field instructors for learning experiences in social agencies and communities. Such experiences include the use of knowledge and understanding in analyses of case and problem situations and in direct service to agency clientele. $\frac{1}{2}$ to 1 unit. Prerequisite: Consent of instructor.

468. Field Instruction, III. The student is assigned to field instructors for learning experiences in social agencies and communities. Such experiences include the use of knowledge and understanding in analyses of case and problem situations and in direct service to agency clientele. 1 to 2 units. Prerequisite: Consent of instructor.

469. Field Instruction, IV. The student is assigned to field instructors for learning experiences in social agencies and communities. Such experiences include the use of knowledge and understanding in analyses of case and problem situations and in direct service to agency clientele. 1 to 2 units. Prerequisite: Social Work 422, 466, 467, and 468.

481. Social Services and Welfare Policy, I. The function, nature, and scope of the social welfare institution; the social services as a response to social, personal, and economic problems of people; effects of economic and social growth and change on the welfare enterprise; current provisions of money aid programs and services for the aged, children, court wards, and the mentally and physically ill. 1 to 1½ units.

482. Social Services and Welfare Policy, II. Critical evaluation of current social services and welfare policy issues and alternatives for their solution; methods of planned change in the resolution of policy issues. ½ to 1 unit. Prerequisite: Consent of instructor.

484. National Social Welfare Policy, I. Analysis of the impact of changing economic and political doctrines, of ideological differences and struggle, and of major events such as wars, depressions, urban strife, the civil rights revolution, sustained poverty, and cybernetics on national social policies and the operation of social welfare programs. Treatment is in a historical and institutional context. Primarily directed toward the development of ideas to guide determination of social work posture and context. ½ to 2 units. Prerequisite: Social Work 481 or consent of instructor.

485. National Social Welfare Policy, II. Emphasis is on the case approach within the context of basic political and governmental processes which influence the development, enactment, and application of national policy. Analytical study of the background, legislative history, amendments, judicial interpretations, and operation of major national acts comprising our national social welfare policy, or bearing directly on social welfare such as the Social Security Act, the Employment Act, the Civil Rights Acts, and the Economic Opportunity Act. ½ to 2 units. Prerequisite: Social Work 484 or consent of instructor.

491. Research Seminar. Seminar for students preparing research projects, either in groups or individually. Experience in the application of research methods to current social work problems. 0 to 2 units. Prerequisite: Consent of instructor.

492. Seminar on Models for Directed Change. Same as Sociology and Urban Planning 492. Construction and analysis of models for planned intervention at the personal, small group, and community levels. Construction of models as interpretations of behavioral science theory; extrapolating of hypotheses and of guides to intervention from the models. Readings from several disciplines as relevant. ½ or 1 unit. Prerequisite: Consent of instructor.

493. Methodological Issues in Social Work Research. Analysis of issues and problems inherent in selected social research methods, to identify special problems in research on social work practice. Methodological problems of proof and verification, levels of generalizability, meaning of data, objectivity and reliability in use of judgements. A framework is developed for reformulation of research problems and for selection of research. methods. 1 unit. Prerequisite: One course in social research methods.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Methods of Social Work Intervention. Examination of the methods of social work intervention (casework, group work, and community organization) utilized in various social work agencies and social welfare settings. Understanding of the values, knowledge, principles, and processes of social work practice is emphasized. ½ to 1 unit. Prerequisite: Credit or registration in Social Work 226.

316. Social Services for Children. Child welfare practice in relation to the state's responsibility for guardianship, the juvenile court, employment, and regulation of child-care facilities; an examination of services which support, supplement, or substitute for

parental care of children; consideration of trends and issues in child welfare planning. ½ to 1 unit. Prerequisite: Credit or registration in Social Work 300, or consent of instructor.

318. Special Problems. A small group seminar for independent study of a topic(s) of special interest to the field of social welfare. Emphasis is on examination and discussion of significant and current social welfare issues and problems. ½ to 1 unit. Prerequisite: Credit or registration in Social Work 300; consent of instructor.

333. Introduction to Social Group Work. Background information regarding the place and development of social group work. Attention is given to the nature of groups in society, the development of group work services, concepts of group leadership, and the nature of group activities. Material is presented through lecture and discussion with illustrations from the field of practice in informal education, recreation, and social group work. ½ unit. Prerequisite: Introductory courses in sociology, psychology, and social sciences.

SOCIOLOGY

The Department of Sociology offers graduate work leading to the Master of Arts and Doctor of Philosophy.

In order to be considered for admission, students intending to major in sociology must offer:

(1) A grade-point average of at least 4.0. Applicants with averages between 3.75 and 4.0 are considered on an individual basis;

(2) A minimum of nine semester hours of undergraduate work in sociology;

(3) One or more courses in quantitative research methods in sociology;

(4) Fifteen semester hours in one or more of the following subjects: anthropology, economics, history, mathematics, philosophy, political science, and psychology. Training in logic, philosophy of science, mathematics, and statistics is strongly recommended for students expecting to do graduate work in sociology.

Applicants must submit Graduate Record Examination scores on the tests of verbal ability, quantitative ability, and on the advanced test in sociology.

The prerequisite for a graduate minor in sociology is six hours of undergraduate work in sociology. Students intending to take a minor in sociology must obtain the approval of a department adviser.

Master of Arts. Candidates for the degree of Master of Arts must earn ten units of graduate credit, including Sociology 385 and 386, or equivalent. They must also pass the departmental comprehensive examination on the master's level.

Doctor of Philosophy. Study for the doctorate must include Sociology 385, 386, and 387, or equivalent. Information on additional requirements, including the language requirement, is given in the department manual for graduate students.

FACULTY

Professors: F. C. Fliegel (Head of Department), D. J. Bordua, B. Farber, C. L. Folse, J. E. Hulett, Jr., N. G. Jacobs, H. M. Johnson, B. Karsh, Rita J. Simon.

Associate Professors: H. M. Choldin, K. W. Dickman, G. R. Lueschen, S. Sudman, N. Wiley.

Assistant Professors: W. C. Jenné, S. Kronus, S. C. McPhail, Jr., A. M. Orum, M. Solaun, K. E. Southwood, G. F. Summers, J. C. van Es, P. D. Wiebe, J. D. Woelfel.

COURSES FOR GRADUATES

400. General Sociology. Systematic sociology, with emphasis on the development and prob-

lems of modern structural-functional theory. Analysis of the works of major contributors to functionalism, e.g., Durkheim, Weber, Merton, and Parsons, and an examination of the ways in which their work converges to form a cumulative body of sociological theory. 1 unit.

405. European Sociology—Recent Developments. Analyses of recent developments and original contributions of European sociology. A review of the major sociological centers in France, Germany, Great Britain, Poland, Russia, and Scandinavia, and an emphasis on special problems selected on the basis of their theoretical importance. 1 unit. Prerequisite: Sociology 300. LUESCHEN.

406. Recent Developments in Sociological Theory in the United States. The emphasis of this course is on American theorists other than Talcott Parsons. The specific theorists treated may vary somewhat from year to year. 1 unit. Prerequisite: Sociology 300.

407. Population Studies and Demographic Analysis. Same as Rural Sociology 407. Nature and development of population theories; population growth and measures of fertility, reproduction, mortality, morbidity, and internal migration; indices, rates, and standardizations used in analyzing compositional characteristics. Methods in population projections, relationship of economic, sociological, and psychological factors to population changes. 1 unit. Prerequisite: Twelve hours of social science and introductory statistics, or major in sociology, or consent of instructor. FOLSE.

408. The Sociology of Human Fertility. Comparative studies of levels of fertility in different societies and in the same societies at different times. Analysis of sociological, psychological, and demographic factors affecting human reproduction and family planning, and consequences of differentials in fertility. 1 unit. Prerequisite: Graduate standing or consent of instructor.

409. Psychological Scaling. Same as Psychology 409. Scaling theory and methodology, with emphasis upon measurement in psychophysics, differential psychology, and social psychology. Offered in 1970-1971 and in alternate years. 1 unit. Prerequisite: Psychology 307. TUCKER.

411. Sociology of Science. Social factors in the origin of broad theoretical orientations in science, such as the mechanistic doctrine, vitalism, historicism, atomism, holism, relativism, and indeterminism; social effects of these orientations; the social origin of scientists; ethos of science; the relationship of science to culture change; the variety and nature of scientific institutions. 1 unit. Prerequisite: Sociology 311 or consent of instructor.

412. Seminar on Social and Cultural Relations of Personality. Problems of theory, concepts, and methodology in the study of the relationship of individual personality and social behavior to culture and social organization. The course is based on a critical examination of the literature and touches on special aspects of the basic problem such as levels of culture, family and class structure, behavior disorders, and social change in relation to the individual. 1 unit. HULETT.

413. Computer Applications in Social Statistical Research. Same as Computer Science and Psychology 413. Computer procedures for the analysis of sociological and psychological data, including probability matrices, dominance matrices, clique analysis, regression analysis, analysis of variance and covariance, canonical correlations, discriminant analysis, and factor analysis. 1 unit. Prerequisite: Sociology 387 or equivalent in statistics; may be taken concurrently with Sociology 387. DICKMAN.

414. Seminar on Social Interaction. Same as Communications 414. An analysis of social interaction based on the social psychology of C. H. Cooley, G. H. Mead, and W. I. Thomas. Problems of theory, concepts, and method. 1 unit. Prerequisite: One unit of graduate credit in sociology. HULETT.

417. Seminar in the Sociology of Law. Review and analysis of selected areas of theory and research in the sociology of law. The focus varies from year to year. Topics covered in different years include such areas as civil litigation and the civil courts, police operations

and the sociology of law and order, sociological theories of justice and the operations of legal agencies. Students should consult the instructor about the area to be covered in a particular semester. 1 unit. Prerequisite: Sociology 317. BORDUA, SIMON.

418. Seminar in Industrial and Economic Sociology. Same as Labor and Industrial Relations 418. Discussion and individual research on such topics as industrialization, labor-management relations as group relations, the interrelations of industry and community, technology and the structure of controls in industry, and the problem of a social economics. 1 unit. Prerequisite: Sociology or Labor and Industrial Relations 318, or consent of instructor. KARSH.

421. Seminar on Research in Marriage and Family Life. Analysis of relationships between research methodology and conceptual schemes employed to study family life; critical examination of typical studies which illustrate alternatives in the conceptualization of family interaction and the nature of the family unit. 1 unit. Prerequisite: Consent of instructor. FARBER.

422. Theory of Social Groups. A comparative survey of selected conceptual systems currently used for the analysis of human groups. The systems are examined with a view to determining the origins and referents of the concepts, their interrelations, and their utility as sources of testable generalizations relevant to the solution of empirical problems in group analysis. 1 unit.

424. Sociological Analysis of Treatment Institutions. Analysis of research on the social structure of prisons, training schools, and mental hospitals; sociological approaches to measuring the effects of innovations in institution organization and program; measuring the influence of institutional experience on the post-release behavior of its inmates. Class makes one or more trips to institutions; total travel cost for the term not to exceed $10.00. 1 unit. Prerequisite: Sociology 324 and 333, or consent of instructor.

425. Racial and Cultural Minorities. A study of the factual and conceptual aspects of minority status as determined by racial and cultural criteria. 1 unit. Prerequisite: Undergraduate major or minor in sociology or anthropology.

426. Sociological Research on the Extramural Treatment of Deviant Behavior. Analysis of sociological research on community programs for the treatment and prevention of deviant behavior, including adjudication and disposition in delinquency and mental disorder, probation, parole, out-patient and day- or night-only care, work-release, community correctional treatment. Class makes one or more trips to observe field research; total travel cost for the term not to exceed $10.00. 1 unit. Prerequisite: Sociology 324 and 333, or consent of instructor.

429. Seminar in the Sociology of Religion. Detailed examination of research in the sociology of religion; the substantive character of religious groups and institutions as revealed by this research; significance of the research in the light of sociological theory and of other fields of sociological concern; the value of the current research methodology. 1 unit. Prerequisite: Sociology 400.

431. Seminar on Social Deviance. Systematic analysis of advanced theory and research on the social processes by which behavior becomes defined as deviant, the conditions promoting such behavior, and the career patterns of deviant persons, with particular attention to crime, delinquency, and mental disorder. 1 unit. Prerequisite: Sociology 331 and 333, or consent of instructor. BORDUA.

432. Special Problems in Theory and Research on Deviant Behavior. A seminar concerned with the critique of recent theory and research on selected problems in the study of delinquency, crime, and mental disorder, and the collaborative development of new theory and research designs. 1 unit. Prerequisite: Sociology 331 and 333, or consent of instructor.

435. Field Instruction in Sociological Research on Treatment of Deviant Behavior. Problems of designing and conducting sociological research in agencies for the treatment of deviant behavior (prisons, training schools, police departments, courts, mental clinics,

mental hospitals); supervised training and practice in the functions of sociologists in these agencies. Application for admission to this course should be made early, preferably no later than the April prior to the summer session in which enrollment is desired, so that field placement arrangements can be made. S; 1 unit. Students may reregister in a subsequent summer for a second unit of credit, provided there is appreciable contrast in their two field locations. Prerequisite: Sociology 431, 333, and 424, or consent of instructor.

440. Political Sociology. An analysis of the impact of social cleavages and cohesion on the operation of political institutions and movements; the place of conflict and power in sociological theory; composition and behavior of power elites; participation in political associations; national and local power structure; social functions of electoral behavior; modern national and mass political movements. 1 unit. Prerequisite: A course in sociological theory or consent of instructor. WILEY.

444. Seminar in Public Opinion. Same as Communications 444. Development and theory of public opinion process in society; censorship, interest groups, and propaganda; mass media and public opinion. 1 unit.

450. Problems of Soviet Society in Transition. This seminar examines certain major problems inherent in directed social change from an agricultural to an industrial system under a totalitarian regime of the Soviet type. Attention is focused on such areas as the different phases of the revolutionary process, inconsistencies between ideological premises and the demands of industrialism, the unanticipated consequences of social change, the simultaneous impact upon the social system of industrialism and totalitarianism, and implications of the Soviet experience for other countries. 1 unit. Prerequisite: Consent of instructor.

456. Organizational Sciences, I. Same as Business Administration 410, Political Science 460, and Psychology 453. An introduction to the principal theories and important empirical research in various disciplines that study organizations. In addition to examination of the subject matter content of various disciplines, students critically examine the capacities and limitations of the various fields to make contributions to the study of organizations. 1 unit. Prerequisite: Enrollment as a major in organizational sciences in a cooperating program or approval of instructor.

457. Organizational Sciences, II. Same as Business Administration 411, Political Science 461, and Psychology 454. An introduction to the principal theories and important empirical research in various disciplines that study organizations. In addition to examination of the subject matter content of various disciplines, students critically examine the capacities and limitations of the various fields to make contributions to the study of organizations. 1 unit. Prerequisite: Sociology 456.

474. Survey Methods in Marketing Research. Same as Business Administration 471. An analysis of survey methods in marketing with emphasis on sample design, data collection, and data processing; an advanced course in the methods required to design, implement, and evaluate a research project. 1 unit. Prerequisite: Sociology 185, Economics 171, or equivalent.

476. Urban Communities and Urbanization. Intensive study of special aspects of the urbanization process as it affects the life of communities in this and in other countries. 1 unit.

477. Seminar on Community Organization. Same as Rural Sociology 477. Theories relating to the community concept and the analysis of community organization; the process of community change as applied to societies in various parts of the world. 1 unit. Prerequisite: Sociology 275 or consent of instructor. FLIEGEL.

480. Sociological Theory and Method. This course is concerned with the strategy and tactics involved in the construction of specific substantive theories, considering such problems as concept formation, the use and development of models, criteria of good theory, and the role of theory in the development of sociological research. 1 unit.

482. Recent Developments in Sociology. Intensive study of selected topics based on con-

temporary works of major importance in the development of sociological theory. 1 unit. Students may reregister for a total of two units credit.

484. The Sociological Theory of Talcott Parsons. Systematic description of the social system and comparison with the personality and cultural subsystems within the general action system. Theory of structural change in social system is also examined. 1 unit. Prerequisite: Sociology 300 or 400. JOHNSON.

485. The Sampling of Human Populations and Social Organizations. Same as Business Administration and Psychology 485. This course covers procedures for selecting samples from and estimating population parameters for human populations and social organizations. The types of sample designs treated include simple random samples, stratified, and cluster samples together with random number and systematic selection techniques. Emphasis is given to the study of various kinds of advanced sample designs for both area and institutional settings together with the problems involved in the application of analytical statistics to complicated sampling procedures. Each student is required to participate in a field project which involves the actual selection of a cluster sample from the local area. 1 unit. Prerequisite: Sociology 387 or Economics 371, or consent of instructor.

486. Seminar on Experimental Sociology. The logic, design, and analysis of laboratory and field experiments, with special emphasis on the controlled investigation of social processes. 1 unit. Prerequisite: Sociology 385 or equivalent, or consent of instructor.

487. Special Problems in Rural Sociology. Same as Rural Sociology 487. ½ or 1 unit. Prerequisite: One unit of graduate credit in sociology; consent of instructor. STAFF.

490. Individual Topics in Sociology. Supervised individual investigation or study of a topic not covered by regular courses. The topic selected by the student and the proposed plan of study must be approved by the adviser and the staff member who supervises the work. ½ to 2 units. STAFF.

492. Seminar on Models for Directed Change. Same as Social Work and Urban Planning 492. Construction and analysis of models for planned intervention at the personal, small group, and community levels. Construction of models as interpretations of behavioral science theory; extrapolating of hypotheses and of guides to intervention from the models. Reading from several disciplines as relevant. ½ or 1 unit. Prerequisite: Consent of instructor.

494. Multivariate Analysis in Psychology and Education. Same as Educational Psychology and Psychology 494. The principal methods of descriptive statistics used in the analysis of multiple measurements, with emphasis on conventional procedures of factor analysis; profile similarity models; discriminatory analysis; multidimensional scaling. 1 unit. Prerequisite: Psychology 307 or Educational Psychology 496; consent of instructor. TUCKER.

499. Thesis Research. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Social Systems and Institutions. An advanced discussion of general principles and concepts in sociology; among the topics discussed are culture, social structure, socialization, primary groups, social stratification; their application to problems in political sociology, industrialization, race relations, religion, and delinquency; the bearing of these upon larger problems of social order and social change. Designed for advanced undergraduate majors in sociology and other social sciences and for graduate students in sociology without adequate preparation for graduate work. ½ or 1 unit. Prerequisite: Sociology 100 or eight hours of social science, or consent of instructor. JOHNSON.

311. Sociology of Intellectual Life. A comparative sociological analysis of the development of the intelligentsia in Europe and elsewhere. Central concerns include the institutional supports for intellectual work under various social and cultural conditions, the social origin and status of different types of intellectuals, the formation of distinct scientific

traditions, and the relationships of these traditions to ideology, literature, and philosophy. This involves a critical scrutiny of the theoretical literature and methodology of the sociology of knowledge. ½ or 1 unit. Prerequisite: Sociology 100 or eight hours of social science, or consent of instructor. VUCINICH.

315. Sociology of Education. Same as History and Philosophy of Education 315. Objective comparative study of education as a social process in various cultures and historical periods, with main emphasis on present education in countries which share Western civilization. ½ or 1 unit. Prerequisite: Sociology 100 or 151.

316. Sociology of Adolescence. Adolescence in modern societies; social class, ethnic and minority group membership, and other variables as in social development, search for identity inter-generational conflict, academic and social failure, and juvenile delinquency; the socializing institutions of family, education, peer culture, politics, religion, welfare and social control, the work world and recreation and leisure. Emphasis on research. ½ or 1 unit. Prerequisite: Sociology 100 or 151.

317. Sociology of Law. A general treatment of the social origins and consequences of law and legal process. Special emphasis is placed on problems of legal change, on the structure and functioning of legal sanctions. Some attention is paid to law and law-like phenomena in other societies, including primitive societies, but the main focus is on American society. ½ or 1 unit. Prerequisite: Sociology 100. BORDUA, SIMON.

318. Industry and Society. Same as Labor and Industrial Relations 318. Introduction to the sociology of economic institutions; selected problems of technological change and industrialization; corporate organization and trade union structure; human relations in industry and the changing bases of managerial authority; changing consumption patterns and the redefinition of work and leisure. ½ or 1 unit. Prerequisite: Six hours of sociology including one of the following: Sociology 218, 223, 300, 322, 326, or consent of instructor. KARSH.

320. Social Roles. Contemporary role theory and related concepts such as social status and social interaction; age-sex, vocational, social class, and other role types; applications of this theory to the study of the socialization process and personal adjustment, and the analysis of critical group situations and social change. ½ or 1 unit. Prerequisite: Sociology 100 or 151. HULETT.

321. Family and Kinship. An analysis of family and kinship, with major concentration on the American family. Implications of the American kinship system for trends in the courtship and mate selection, interaction among kin, and other areas of family life are investigated. ½ or 1 unit. Prerequisite: Sociology 100, or eight hours of social science, or consent of instructor.

322. Sociology of Bureaucracy and Administrative Organization. An analysis of major types of formal organizations from the viewpoint of generalized theories of organization and of substantive theories of bureaucratization and rationalization. Among the formal organizations studied are business enterprises and unions, educational and medical institutions, and non-voluntary organizations. The interrelations between bureaucracy, ideology, and social structure are particularly emphasized. ½ or 1 unit. Prerequisite: Nine hours of sociology including Sociology 300, or consent of instructor.

323. The Small Social Group. Same as Psychology 323. Theory, observation, and analysis of face-to-face social groups, such as friendships, cliques, clubs, committees, and laboratory and experimental groups. Deals with the characteristics, functions, and forms of interaction of small groups and covers recent theoretical and empirical developments in this field of sociology. ½ or 1 unit. Prerequisite: Sociology or Psychology 201.

324. Penology. Probation; parole; methods of institutional treatment. ½ or 1 unit. Prerequisite: Sociology 331.

326. Social Mobility and Class Structure. An advanced course in social stratification, concerned with patterns, causes, and consequences of social mobility and immobility. Includes the analysis of rising and falling classes in industrial and developing countries

and the circulation of political, social, and economic elites, as well as institutional sources of individual mobility. ½ or 1 unit. Prerequisite: Sociology 223 or consent of instructor.

328. Sociology of Asian Religions. A comparative study of the influences of religion on the societies of Asia, and vice versa, focused on the problems of social change and development. Concentration is upon the religions and social systems of Iran, India, Thailand, China, and Japan. ½ or 1 unit. Prerequisite: Sociology 229 or consent of instructor. JACOBS.

329. Comparative Family Institutions. Cross-cultural analysis of family institutions, with special reference to vital and demographic backgrounds and with stress on property, authority, and handling of deviance, and relationship to religion, economy, and polity. ½ or 1 unit. Prerequisite: Sociology 185. FARBER, LEWIS.

331. Criminology. Nature and extent of crime; past and present theories of crime causation; criminal behavior in American society and its relation to personal and cultural conditions. ½ or 1 unit. Prerequisite: Sociology 100 or 151.

332. Research Methods in Social Psychology. Same as Psychology 332. A lecture and laboratory course in the methods and techniques of social psychological research. Emphasis is given to methods for laboratory experiments on small groups. ½ or 1 unit. Prerequisite: Psychology or Sociology 201; Psychology 235 or Sociology 184 and 185; consent of instructor or academic counselor of the Department of Psychology.

333. Sociology of Mental Health. Mental health issues from social organizational, demographic, and social psychological perspectives; definitions of mental illness and treatment practices relating to changing social psychological and political ideologies. The patient and the mental hospital, and the potential role of the behavioral scientist as an agent of research, treatment, and change, with special reference to current mental health action programs, are investigated. 1 unit. Prerequisite: Sociology 100 or 151, and one course in abnormal psychology and one in social psychology, or consent of instructor.

340. Social Movements. Analysis of the factors in the formation and dynamics of social movements as collective behavior; patterns of growth, types of leaders, control mechanisms. ½ or 1 unit. Prerequisite: Sociology 100 or 151.

343. Social Change in Developing Areas. Same as Rural Sociology 343. Description and analysis of recent social and cultural changes occurring in new nations and developing economies. Special attention is given to problems of traditional social structure undergoing modernization. Social factors in economic growth, caste and class, nation-building, urbanization and population composition, education, family and religion. ½ or 1 unit. Prerequisite: Sociology 100 or 151, or equivalent. FLIEGEL, KARSH.

344. Public Opinion. Same as Communications 344. Opinion changes and control; propaganda; interest groups and opinion; critical review of methods of measurement. ½ unit. Prerequisite: Sociology 100 or 151. SIMON.

350. Soviet Social Institutions. This course analyzes the major social institutions of Soviet society. Special attention is paid to the structural consequences of Communist ideology, totalitarianism and industrialism, and to comparison with and implications for American society. The major areas covered are: population data and their sociological implications; history, values, and ideology; political institutions; economic institutions; social stratification and mobility; the nationalities; the family and education; communications and public opinion; socialized medicine. ½ or 1 unit. Prerequisite: Sociology 100 or consent of instructor. The prerequisite does not apply to majors and minors in Russian language and area studies.

351. Advanced Social Psychology. Same as Communications and Psychology 351. An integrative treatment of individual behavior variables in relation to group variables. ½ or 1 unit. Prerequisite: Sociology or Psychology 201; Psychology 235 or Sociology 385, or a comparable statistics course. MCGRATH, STEINER.

352. Attitude Theory and Measurement. Same as Communications and Psychology 352.

A comprehensive survey of psychological theories of attitude organization and change, and a theoretical and methodological analysis of the various techniques used to measure attitude. These theories and methods are evaluated with respect to empirical research in the area. ½ or 1 unit. Prerequisite: Sociology or Psychology 201; a course in statistics. FISHBEIN.

355. Chinese Society. Systematic treatment of China's social, cultural, and demographic heritage and of the impact of the west on an ancient civilization; the processes of planned and unplanned change in Chinese society. Topics include: peasant-land economy; the family; patterns of social stratification and social mobility; the persistence of traditional forms and the adoption and adaptation of new patterns. ½ or 1 unit: Prerequisite: Sociology 100, 151, and 152, Rural Sociology 117, or consent of instructor. WONG.

359. The Social Psychology of Organization. Same as Psychology 359. Analysis of the interrelationships between social and psychological factors, on the one hand, and organizational structure and process, on the other; emphasis on sources, consequences, and modes of resolution of intra-individual, intra-organizational, and inter-organizational conflict. 1 unit. Prerequisite: Psychology 355 or Sociology 322. MCGRATH.

360. Sociology of the Professions. This course examines the nature, position, functions, and growing importance of the major professions in the contemporary industrial (or industrializing) society. Particularly close attention is paid to the relationship between the social system and the various professional "communities," recruitment, professional socialization, and bureaucratic vs. independent practice. ½ or 1 unit. Prerequisite: Sociology 100 or consent of instructor.

369. Introduction to Human Ecology. Same as Anthropology, Geography, Health Education, Physiology, Psychology, Veterinary Medical Science, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations, and physiological, psychological, and sociological adjustments to environment, regulation of populations, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology; one year of anthropology, geography, geology, or sociology.

371. Comparative Social Institutions. This course examines, in a comparative perspective, some of the major institutional complexes of social systems, such as family and kinship structures, occupations, political institutions, and social stratification and mobility. Illustrative materials are drawn from a variety of societies, including primitive nonliterate societies and advanced industrial societies such as the United States, Germany, and the Soviet Union. ½ or 1 unit. Prerequisite: Sociology 100 or consent of instructor. JACOBS.

373. Latin-American Social Organization and Institutions. Analysis of contemporary institutional and social class structures in Latin-American communities and societies, and their relationship to certain religious and family patterns; the influence of the past and present trends in urbanization, ecological organization, and population growth upon Latin-American social systems and institutional organization. ½ or 1 unit. Prerequisite: Sociology 100 or 151, or consent of instructor. SOLAUN.

374. Problems in Human Ecology. Same as Anthropology, Geography, Health Education, Physiology, Psychology, and Veterinary Medical Science 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multidisciplinary studies of selected current problems. 1 unit. Prerequisite: Sociology, Anthropology, Geography, Health Education, Physiology, or Zoology 369.

382. Development of Sociological Thought. An historical analysis of selected areas of sociological thought, stressing their existential base as meanings systems; includes the origin of sociology, its relation to social Darwinism, psychoanalysis, the debate over functionalism, and the cultural "relevance" of social theories generally; figures include Comte, Spencer, Summer, Ward, Freud, Durkheim, Weber, etc. 1 unit. Prerequisite: Sociology 100, or eight hours of social science, or consent of instructor.

385. Social Statistics, I. Deals intensively with descriptive statistics, probability, statistical

inference, and significance testing by means of both parametric and nonparametric tests, and the various measures of association. 1 unit. Prerequisite: Sociology 185 or Mathematics 122 or 123, or consent of instructor.

386. Methods of Field Research. Same as Psychology 386. Instruction, training, and supervised practice in methods of field research as a basic tool of sociology. Major emphasis is placed on the role of the field researcher as participant, observer, and interviewer in various kinds of research settings, and on approaches to and applications of field data. Each student develops and executes a field research project dealing with some aspect of institutional, occupational, or general community activity and structure. $^1/_2$ or 1 unit. Prerequisite: Sociology 184 and 185, or Psychology 235.

387. Social Statistics, II. Treats analysis of variance, analysis of covariance, multiple and partial correlations, and complicated sampling procedures. A semester problem is developed which emphasizes integration and application of various statistical techniques to sociological problems. $^3/_4$ or 1 unit. Prerequisite: Sociology 385.

SPANISH, ITALIAN, AND PORTUGUESE

(Including Catalan)

The Department of Spanish, Italian, and Portuguese offers work leading to the Master of Arts and Doctor of Philosophy in Spanish, Italian, or Portuguese, and to a Master of Arts in the Teaching of Spanish. Fields of concentration are Spanish linguistics, Spanish literature, Latin-American literature, Italian literature, and Portuguese literature.

The departmental admission requirement is a grade-point average of at least 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis. Prerequisite for a graduate major is an undergraduate major in one Romance language or Latin, or consent of the department. Prerequisite for a minor is consent of the department.

Students doing graduate work for any advanced degree in Spanish must possess or acquire a practical command of the language. For the Doctor of Philosophy, some knowledge of Latin and Italian or Portuguese is required. The Latin requirement may be met by taking a minimum of one semester of Latin (two semesters in the specialization in Spanish linguistics) while in residence for the degree. Parallel training in one or more other languages or literatures, such as English, French, German, Greek, Italian, Latin, and Portuguese, is desirable.

Master of Arts.

(1) *Spanish or Spanish-American Literature.* Minimum requirements are: (a) any of the following not previously included in an undergraduate program: Spanish 305, 306, 307, 308, 309, 311, 314, 331 or 332, 351, 352; (b) Spanish 405; one of Spanish 415, 417, 419, 425; two of Spanish 421, 422, 423, 424, 426; one of Spanish 431, 432, 433, 434, 437, 438. The course program may be supplemented by courses from the doctoral list or by courses totaling one or two units in a minor or one unit in each of two minors.

(2) *Spanish Linguistics.* Minimum requirements are: (a) any of the following not previously included in an undergraduate program: Spanish 305, 306, 307, 308, 309, 311, 314, 331 or 332, 351, 352, 382; general linguistics: Linguistics 300, 302; and (b) Spanish linguistics: Spanish 451 or 453; general linguistics: Linguistics 462; Spanish and Spanish-American literature: one each from two of the following groups: (i) Spanish 415, 417, 419, 425; (ii) Spanish 421, 422, 423, 424, 426; (iii) Spanish 431, 432, 433, 434, 437, 438, 439. The course program may be supplemented by courses from the doctoral list.

(3) *The Teaching of Spanish.* Minimum requirements are: (a) up to three units of any of the following not previously included in an undergraduate program: Spanish 305 or 306, 307 or 308, 311 or 314, and 331, 332, 351, 352, Linguistics 300; (b) one of Spanish 415, 417, 419, 425; one of Spanish 421, 422, 423, 424, 426; one of Spanish 431, 432, 433, 434, 437, 438; (c) Educational Psychology 311, 312; (d) two of History and Philosophy of Education 303, 304, 305. The course program may be supplemented by courses from the doctoral list. See pages 36 and 37.

Doctor of Philosophy.

(1) *With Specialization in the Renaissance and Golden Age.* The minimum requirements, in addition to those for the master's degree, are: Spanish 411; three of Spanish 415, 417, 419, 425; one of Spanish 421, 422, 423, 424, 426; Spanish 453; two seminars.

(2) *With Specialization in the Nineteenth and Twentieth Centuries.* The minimum requirements, in addition to those for the master's degree, are: Spanish 411; one of Spanish 415, 417, 419, 425; three of Spanish 421, 422, 423, 424, 426; Spanish 453; two seminars.

(3) *With Specialization in Latin-American Literature.* The minimum requirements, in addition to those for the master's degree, are: Spanish 411; one of Spanish 415, 417, 419, 425; one of Spanish 421, 422, 423, 424, 426; Spanish 453; three of Spanish 431, 432, 433, 434, 437, 438, 439; two seminars; one of Portuguese 301, 303, 304, 407.

(4) *With Specialization in Spanish Linguistics.* The minimum requirements, in addition to those for the master's degree, are: (a) Spanish linguistics: Spanish 454 and 451 or 435; (b) Spanish and Spanish-American literature: Spanish 411, and one each from two of the following groups: (i) Spanish 425 or other (415, 417, 419); (ii) Spanish 426 or other (421, 422, 423, 424); (iii) Spanish 431 or 432 or other (433, 434, 437, 438); (c) two seminars: Spanish 452 and one in literature or language or general linguistics; (d) minor: general linguistics.

Students working toward the Doctor of Philosophy are admitted with provisional departmental status until their performance in graduate work is judged acceptable for full departmental status by the department's graduate committee. A comprehensive written examination is used as a basis for this judgment. Consult with your adviser about the nature of this examination.

The department should be consulted on the selection of minors.

Candidates for an advanced degree in Italian or Portuguese should consult the department. Provisions are made to fit individual cases.

FACULTY

Professors: A. M. Pasquariello (Head of Department), J. H. D. Allen, J. S. Flores, M. H. Forster, H. R. Kahane, L. Leal, R. E. Lott, R. Montano, Angelina R. Piertrangeli, A. Porqueras-Mayo.

Associate Professors: S. W. Baldwin, Jr., W. C. Blaylock, H. W. Cowes.

Assistant Professors: A. Aiex, D. R. Hershberg, I. Lerner, T. C. Meehan.

Spanish

COURSES FOR GRADUATES

400. Beginning Spanish for Graduate Students. Basic grammar and vocabulary; reading practice. 4 semester hours. No graduate credit.

401. Readings in Spanish for Graduate Students. Continuation of Spanish 400, with special readings in the critical literature of several disciplines. 4 semester hours. No graduate credit. Prerequisite: Spanish 400 or consent of instructor.

405. Spanish Bibliography. An introduction to bibliographical method and to the principal bibliographical resources for the study of Spanish and Latin-American literature. ½ unit. Blaylock.

411. Spanish Literature in the Middle Ages. 1 unit. Prerequisite: Spanish 309. Allen, Baldwin.

415. Renaissance and Baroque Prose in Spain. 1 unit. Prerequisite: Spanish 311 and 314, or equivalent. Allen, Hershberg, Porqueras-Mayo.

417. Renaissance and Baroque Drama in Spain. 1 unit. Prerequisite: Spanish 311 and 314, or equivalent. Flores, Porqueras-Mayo.

418. Seminar in Renaissance and Baroque Literature. 1 unit. May be repeated for credit. Porqueras-Mayo.

419. Cervantes. *Don Quixote* and representative minor works. 1 unit. Prerequisite: Spanish 311 and 314, or equivalent. PORQUERAS-MAYO.

421. Modern Spanish Novel and Essay. 1 unit. COWES, LOTT.

422. Contemporary Spanish Novel and Essay. 1 unit. COWES, LOTT, PASQUARIELLO.

423. Modern Spanish Drama. 1 unit. LOTT, PASQUARIELLO, PIETRANGELI.

424. Contemporary Spanish Drama. 1 unit. COWES, LOTT, PASQUARIELLO.

425. Renaissance and Baroque Poetry in Spain. 1 unit. PORQUERAS-MAYO.

426. Spanish Poetry of the Nineteenth and Twentieth Centuries. 1 unit. PIETRANGELI.

431. Spanish-American Poetry: Middle America. 1 unit. Prerequisite: Spanish 307, 308, and 310, or equivalent. FORSTER.

432. Spanish-American Poetry: South America. 1 unit. Prerequisite: Spanish 307, 308, and 310, or equivalent. FORSTER.

433. Spanish-American Novel: Middle America. 1 unit. Prerequisite: Spanish 307, 308, and 310, or equivalent. LEAL, MEEHAN.

434. Spanish-American Novel: South America. 1 unit. Prerequisite: Spanish 307, 308, and 310, or equivalent. LEAL, MEEHAN.

435. Seminar in Spanish-American Poetry. 1 unit. Prerequisite: Spanish 431 or 432. FORSTER.

436. Seminar in Spanish-American Novel. 1 unit. Prerequisite: Spanish 433 or 434. LEAL.

437. Spanish-American Drama. 1 unit. Prerequisite: Spanish 307, 308, or 310. FORSTER.

438. Spanish-American Essay. 1 unit. Prerequisite: Spanish 307, 308, or 310. LEAL.

439. The Spanish-American Short Story. Intensive and analytical study of the principal *cuentistas* of Spanish America. 1 unit. Prerequisite: Spanish 307, 308, or 310, or equivalent. LEAL.

442. Seminar in Modern Spanish Literature. Study of problems in the works of a major writer or group of writers of the eighteenth or nineteenth centuries. 1 unit. Prerequisite: Spanish 305; Spanish 421 or 423, or equivalent. LOTT.

443. Seminar in Galdós. Research work in novelistic criticism. Prerequisite: Spanish 305 or 306 and 311 or 314; Spanish 421 or 422. 1 unit. LOTT.

444. Seminar in Spanish Realism and Naturalism. Research work in nineteenth-century literary theory and practice in novel and drama. 1 unit. Prerequisite: Spanish 421 and 442. LOTT.

445. Seminar in Twentieth-Century Spanish Literature. 1 unit. Prerequisite: Spanish 421 or 422 or 423 or 424, or equivalent. COWES, LOTT, PASQUARIELLO.

451. Survey of Current Research in Spanish Linguistics. Present-day methods of comparative, historical, and structural linguistics as applied to Spanish. 1 unit. KAHANE.

452. Seminar in Spanish Linguistics. Research work in Castilian and Latin-American linguistics. 1 unit. KAHANE.

453. History of the Spanish Language. 1 unit. KAHANE.

454. Old Spanish. 1 unit. BLAYLOCK, KAHANE.

462. Introduction to Romance Linguistics. See Linguistics 462. ½ unit. Prerequisite: Four semesters of a Romance language or Latin, or equivalent. KAHANE.

471. Teaching College Spanish. A presentation of the problems of the teaching of Spanish and training in their solution, together with a study of procedures, methods, and laboratory techniques. No credit. FLORES.

491. Special Topics in Spanish. ½ or 1 unit. STAFF.

499. Thesis Research. 0 to 4 units. ALLEN, COWES, FORSTER, KAHANE, LEAL, LOTT, PASQUARIELLO, PIETRANGELI, PORQUERAS-MAYO.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

305. Romanticism and Realism in Nineteenth-Century Spanish Literature. A study of representative authors and genres of the nineteenth century, with particular emphasis on the romantic drama and the realistic novel. ½ unit. Prerequisite: Spanish 222 or equivalent. Cowes, Lott, Pasquariello.

306. The Generation of 1898. A study of representative works of Baroja, Azorín, Unamuno, Maeztu, Valle Inclán, Benavente, A. Machado, and others. ½ unit. Prerequisite: Spanish 222 or equivalent. Cowes, Lott, Pasquariello.

307. Spanish-American Literature to 1888. A study of the development of Spanish-American literature from the sixteenth century through the end of the Romantic period. ½ unit. Prerequisite: Spanish 222 or equivalent. Forster, Leal, Meehan.

308. Spanish-American Modernismo. A study of Spanish-American literature from 1888 to the end of World War I. ½ unit. Prerequisite: Spanish 222 or equivalent. Forster, Leal, Meehan.

309. Introduction to Medieval Spanish Literature. Historical and cultural background for the Middle Ages; selected readings in medieval literature from the *Farchas* to the *Corbacho*. ½ unit. Prerequisite: Spanish 305, 306, 307, or 308, or equivalent. Baldwin.

310. Contemporary Spanish-American Literature. A study of Spanish-American literature from World War I to the present. ½ unit. Prerequisite: Spanish 222 or equivalent. Forster, Leal, Meehan.

311. Don Quixote and the Prose of the Golden Age. Introduction to *Don Quixote*, to its relationship to other selected masterpieces of the Golden Age, and to the main currents and forms of Golden Age prose. ½ unit. Prerequisite: Spanish 305, 306, 307, or 308, or equivalent. Cowes, Hershberg, Porqueras-Mayo.

314. Spanish Drama and Poetry of the Golden Age. ½ unit. Prerequisite: Spanish 305, 306, 307, or 308, or equivalent. Flores, Hershberg, Porqueras-Mayo.

331. La Cultura Hispánica: España. ½ unit. Prerequisite: Spanish 222 or equivalent. Flores.

332. La Cultura Hispánica: Hispanoamérica. Required for teacher-training majors in Spanish. ½ unit. Prerequisite: Spanish 222 or equivalent. Leal, Lerner.

351. Phonetics. ½ unit. Prerequisite: Spanish 222 or equivalent. Allen, Baldwin, Flores, Kahane.

352. Syntax. ½ unit. Prerequisite: Spanish 222 or equivalent. Baldwin, Blaylock, Flores, Kahane, Wanner.

371. Spanish for Teachers. A consideration of language problems suggested by teaching experience. S; ½ unit. Prerequisite: Spanish 222 or equivalent. Flores.

382. Language Laboratory Techniques. Same as French, German, and Russian 382. Instruction and practice in the techniques of making foreign-language tapes and integrating them with classroom activity; instruction in the problems of planning and operating a language laboratory. ½ unit. Prerequisite: Three years of a modern foreign language at the college level, or equivalent. Myers.

Catalan

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Studies in Catalan Language. An introductory study of the Catalan language. ½ unit. Prerequisite: Eight hours of Latin or any Romance language. Porqueras-Mayo.

302. Studies in Catalan Literature. An introductory study to some major works of Catalan literature. ½ unit. Prerequisite: Catalan 301. Porqueras-Mayo.

Italian

COURSES FOR GRADUATES

400. Beginning Course for Graduate Students. Basic grammar and vocabulary; reading practice. 4 semester hours. No graduate credit.

403. Storia della letteratura italiana, I. Intellectual and literary movements in Italy from the thirteenth century to the Renaissance. 1 unit. MONTANO.

404. Storia della letteratura italiana, II. Intellectual and literary movements in Italy from the Baroque to the present. 1 unit. Prerequisite: Italian 403. MONTANO.

409. Storia della poesia di Dante. Philosophical and literary interpretation of Dante's works. 1 unit. Prerequisite: Italian 311 or 312 or 313 or equivalent. MONTANO.

411. Italian Literature in the Middle Ages: Petrarch and Boccaccio. 1 unit. PIETRANGELI.

412. Italian Literature in the Middle Ages: Petrarch and Boccaccio. 1 unit. PIETRANGELI.

415. Italian Literature of the Renaissance. 1 unit. PIETRANGELI.

416. Italian Literature of the Renaissance. 1 unit. PIETRANGELI.

422. Manzoni e il romanticismo europeo. Manzoni and the Romantic Movement. 1 unit. Prerequisite: Italian 321 and 322, or equivalent. MONTANO.

451. History of the Italian Language. 1 unit. KAHANE.

452. Seminar in Italian Linguistics. 1 unit. KAHANE, WANNER.

462. Introduction to Romance Linguistics. See Linguistics 462. ½ unit. Prerequisite: Four semesters of a Romance language or Latin, or equivalent. KAHANE.

491. Special Topics in Italian. ½ or 1 unit.

499. Thesis Research. 0 to 4 units. KAHANE, MONTANO, PIETRANGELI.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

Note: The prerequisite for 300-level courses is Italian 101 and 102. Italian 103 and 104 are desirable.

311. Dante: La Divina Commedia. ½ unit. PIETRANGELI.

312. Dante: La Divina Commedia. Continuation of Italian 311. ½ unit. PIETRANGELI.

313. The Divine Comedy. An interpretation of Dante's *Divine Comedy* with special attention to its position in the medieval world. A knowledge of Italian is not required. ½ unit. KAHANE.

321. Modern Italian Literature. ½ unit. HERSHBERG, PIETRANGELI.

322. Modern Italian Literature. ½ unit. HERSHBERG, PIETRANGELI.

Portuguese

COURSES FOR GRADUATES

405. Structure of Brazilian Portuguese: Phonology. Phonetics and phonemics of modern Brazilian Portuguese. 1 unit. Prerequisite: Portuguese 104 or consent of instructor. ALLEN.

406. Structure of Brazilian Portuguese: Morphology and Syntax. Morphemics and syntax of modern Brazilian Portuguese. 1 unit. Prerequisite: Portuguese 405 or consent of instructor. ALLEN.

407. Studies in Brazilian Literature. Advanced study of literary movements, major

writers, and intellectual and cultural ideas in Brazilian literature. The subject matter of the course varies each time the course is offered. 1 unit. Prerequisite: Portuguese 301 or consent of instructor. ALLEN.

408. Studies in Portuguese Literature. Advanced study of literary movements, major writers, and intellectual and cultural ideas in Portuguese literature. The subject matter of the course varies each time the course is offered. 1 unit. Prerequisite: Portuguese 302 or consent of instructor. FORSTER.

462. Introduction to Romance Linguistics. See Linguistics 462. ½ unit. Prerequisite: Four semesters of a Romance language or Latin, or equivalent. KAHANE.

491. Special Topics in Portuguese. ½ or 1 unit. STAFF.

499. Thesis Research. 0 to 4 units. ALLEN, FORSTER, KAHANE.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. Introduction to Brazilian Literature. ½ unit. Prerequisite: Portuguese 201 or consent of instructor. AIEX.

302. Introduction to Portuguese Literature. ½ unit. Prerequisite: Portuguese 201 or consent of instructor. AIEX.

303. A Cultura Luso-Brasileira até 1822. Designed to afford a broad understanding of the origins of Luso-Brazilian civilization and culture. ½ or 1 unit. Prerequisite: Portuguese 201 or 211 or consent of instructor. AIEX.

304. A Cultura Brasileira desde 1822. Designed to afford a broad understanding of contemporary Brazilian civilization and culture. ½ or 1 unit. Prerequisite: Portuguese 201 or 211 or consent of instructor. AIEX.

SPEECH

The Department of Speech offers courses leading to the Master of Arts, Master of Science, and Doctor of Philosophy.

Graduate students interested in the theatre option for the Master of Arts and the Doctor of Philosophy are referred to course listings in the Department of Theatre, page 384, as well as applicable courses listed below.

The admission requirement, as to grade-point average, is at least 3.5 on a 5.0 scale.

For the degree of Master of Arts, students may concentrate in one of these areas: general speech, public address, theatre, oral interpretation, speech and hearing science. They may also select a special curriculum in the teaching of speech.

For the Master of Science, students may take a special curriculum in speech correction.

For the Doctor of Philosophy, students may exercise one of five options: rhetoric and public address; the theatre; speech and hearing science; experimental phonetics; oral interpretation.

In addition to meeting general regulations of the Graduate College, the Department of Speech specifies the requirements listed below.

Master of Arts. The entering student should present the equivalent of sixteen hours of undergraduate work in speech, including these courses or equivalents: voice and diction or fundamentals of speech, oral interpretation, an elementary course in phonetics, an elementary course in the theatre, and an advanced course in public speaking or discussion. A thesis may be required.

A final written examination is required of all candidates. In some cases an oral examination is also stipulated.

Master of Arts in the Teaching of Speech. Candidates for the Master of Arts who are interested in public school teaching should see pages 36 and 37 and also meet the following requirements:

(1) In the area of rhetoric and public address: Speech 311 and 312, one-half unit each;

Speech 322 and 423, one unit each; and education, two units, including the following: History and Philosophy of Education 304 and 305, one unit, and Educational Psychology 311 and 312, one unit; electives, three units, one of which must be in speech.

(2) In the area of theatre: speech, four units, including Speech 352, 451, 452, and one of the following: Speech 361, 362, or 366; education, two units, including the following: History and Philosophy of Education 304 and 305, and Educational Psychology 311 and 312; electives, two units.

Master of Science in Speech Correction. The four-year curriculum preparatory to speech correction or its equivalent is a prerequisite for admission. Students who have not met all the requirements may register on approval of the adviser, the Coordinator of Teacher Education, and the Dean of the Graduate College.

Requirements include four units of speech selected from the following: Speech 475, 476, 481, 483, 484, 486, 488, 489, 491, 495; one unit from History and Philosophy of Education 304 and 305, and one unit from Educational Psychology 311 and 312; two units of electives. The electives may be in speech, in psychology, or, in exceptional cases, in other fields.

Doctor of Philosophy. Students are accepted as candidates for the doctor's degree who present either a well-rounded undergraduate education with at least sixteen hours of credit in speech or who hold a master's degree in speech or theatre from an accredited institution.

FACULTY

Professors: R. E. Nebergall (Head of Department), J. J. Bateman, Clara M. Behringer, K. Burns, A. J. Derbyshire, B. W. Hewitt, H. L. Mueller, R. Murphy, Marie H. Nichols, J. J. O'Neill, J. W. Scott, C. H. Shattuck.

Associate Professors: Mary H. Arbenz, K. W. Broadrick, Naomi W. Hunter, Frances L. Johnson, M. E. Joseph, C. W. Kim, L. W. Olson, E. W. Stark, B. R. Works, W. R. Zemlin.

Assistant Professors: J. C. Ahart, Phyllis B. Arlt, J. D. Armold, Ruth A. Clark, R. G. Daniloff, W. DeMarco, M. V. Doyle, Euline D. Eilbracht, Joan G. Erickson, R. L. Ince, J. L. Locke, Joanna H. Maclay, F. L. Nasca, Elaine P. Paden, Lois J. Sanders, T. H. Shriner, F. H. Silverman, R. K. Simpson, S. H. Thomas, J. W. Wenzel.

COURSES FOR GRADUATES

400. Seminar in Dramatic Form and Structure. Same as Theatre 400. Studies in the relationship of dramatic form and structure to the contemporary production of historical and modern plays. 1 unit. Prerequisite: Theatre 361 and 362, or equivalent; consent of instructor.

403. Seminar for Teachers of Speech. Investigation of current principles, materials, and developments in the field of speech and of their relationship to the teacher. 1 unit. Burns.

411. The Greek Tradition in Rhetoric and Oratory. The development of the Greek tradition in rhetorical theory, practice, criticism, and pedagogy from Homer to the Renaissance; analysis of the contributions of major figures and works to that tradition. 1 unit.

412. The Roman Tradition in Rhetoric and Oratory. Development of the Roman tradition in rhetorical thought and practice from Cicero through the English Renaissance. 1 unit.

420. Quantitative Methods in Rhetorical Analysis. An introduction to the principles, procedures, and tools of research used in the quantitative analysis of the oral communication situation, including the experimental designs and statistical methods applicable to rhetorical analysis, and the identification, control, and measurement of rhetorical variables. Students participate in planning, executing, and reporting a limited experimental project investigating some oral communication variable. Offered in 1970-1971

and in alternate years. 1 unit. Prerequisite: Introductory course in statistics; consent of instructor.

423. The Rhetoric of Aristotle. Study of the *Rhetoric* in relation to other works of Aristotle. 1 unit.

430. Contemporary Theories of Oral Communication. Systematic study of speech-making and discussion as related to contemporary views of communication; examination of the theoretical literature and experimental evidence. 1 unit. Prerequisite: Consent of instructor.

436. Seminar in Theories and Procedures of Discussion. Investigation of the history, structure, and dynamics of dialectical forms of speech such as dialogue, panel, forum, debate, and parliamentary practices, with consideration of ethics, freedom of speech, and the forming of public opinion. 1 unit.

438. Seminar in Rhetorical Theory. Study of special topics in the history of rhetorical theory. 1 unit; may be repeated for a maximum of four units.

441. Historical Background of Oral Interpretation. Historical survey of British and American theories of interpretation. 1 unit.

442. Seminar in Oral Interpretation. Investigation of basic problems in the history, nature, and function of oral interpretation. 1 unit. Prerequisite: Speech 441; consent of instructor.

443. Seminar in the Oral Interpretation of Individual Literary Style. Examination of the literary style of an individual writer or selected writers, through research, discussion, and oral readings; subject announced each semester. 1 unit; may be repeated for a maximum of 2 units. Prerequisite: Speech 344.

451. Problems in Play Directing in the Educational Theatre. Same as Theatre 451. Study of the audience, play selection, the actor's abilities and needs, tryouts and casting, conduct of rehearsals and methods of directing, the dramatic club, contests and festivals. 1 unit. BEHRINGER.

452. Problems in Play Production in the Educational Theatre. Same as Theatre 452. Study of the school auditoria and stages, stage machinery and equipment and their use, lighting facilities and their use, organization of backstage crews, scene shifting and stage management, production problems of special types of plays. 1 unit. BEHRINGER.

461. Advanced Theatre Techniques. Same as Theatre 461. Individual development of advanced techniques of acting and staging through supervised participation in public productions. ½ or 1 unit. Prerequisite: At least one semester of graduate study in the area of theatre; consent of head of department and of instructor.

463. Seminar in the History of Acting. Same as Theatre 463. Studies in the history and theory of the art of acting. 1 unit. Students may accumulate maximum credit of two units. Offered in 1971-1972 and in alternate years. ARBENZ.

465. Seminar in Theatre Art. Same as Theatre 465. Studies in the aesthetics of the theatre. 1 unit. HEWITT.

466. The American Theatre Since 1900. Same as Theatre 466. Major developments in acting, production, playwriting, organization, and operation. 1 unit. BEHRINGER.

468. Seminar in Theatre History. Same as Theatre 468. Studies in the history of the theatre. 1 unit. HEWITT.

469. The Stage History of Classic English Plays. Same as Theatre and English 469. Analysis and reconstruction of past productions of classic plays, with special reference to Shakespeare. 1 unit. Prerequisite: One year of work in dramatic literature or theatre history; consent of instructor. SHATTUCK.

472. Psychoacoustics of Speech. Theory and principles of auditory perception of speech; survey of experimental and theoretical literature; laboratory demonstration and experimentation. 1 unit. Prerequisite: Speech 375, 376, 391, or consent of instructor. O'NEILL.

473. Seminar in Phonetics. Same as Linguistics 473. Advanced study in phonetic theory and noninstrumental phonetic investigation. 1 unit. Prerequisite: Consent of instructor.

475. Experimental Phonetics, I. Same as Linguistics 475. Theoretical consideration of speech as motor behavior, with special reference to physiological investigations of normal respiration, phonation, and articulation. Survey of the experimental literature. 1 unit. Prerequisite: Consent of instructor. ZEMLIN.

476. Experimental Phonetics, II. Same as Linguistics 476. Theoretical consideration of speech as an acoustical phenomenon, with special reference to acoustical investigations of voice and speech sounds. Survey of the experimental literature. 1 unit. Prerequisite: Consent of instructor. ZEMLIN.

477. Measurement of Speech, I. Same as Linguistics 477. Principles and methods of measuring speech action. Special action recorders and transducers; techniques of analysis; problems of experimental design. Laboratory experimentation. 1 unit. Prerequisite: Consent of instructor; credit or registration in Speech 475. ZEMLIN.

478. Measurement of Speech, II. Same as Linguistics 478. Principles and methods of measuring the acoustical phenomena of speech. Oscillographic measurement of vocal variables; special instruments and media for automation graphic recording; analysis of data; problems of experimental design. Laboratory experimentation. 1 unit. Prerequisite: Consent of instructor; credit or registration in Speech 476. ZEMLIN.

481. Seminar in Neuropathologies of Speech and Language. Advanced study of speech, vocal, and linguistics problems associated with cerebral palsy and aphasia. The following topics are offered in rotation, one or two each semester: neurological aspects, aphasia, cerebral palsy. 1 unit; may be repeated for a maximum of three units. Prerequisite: Consent of instructor.

482. Seminar in Stuttering. Principles, theories, and methods of clinical management of stuttering behavior in children and adults. 1 unit. Prerequisite: Speech 388.

483. Psychology of Speech and Hearing Disorders, I. Same as Psychology 483. A survey of psychological techniques utilized in the clinical and experimental study of speech and hearing disorders, with special reference to speech disorders. Review of research findings and development of experimental designs. 1 unit. Prerequisite: Consent of instructor. O'NEILL.

484. Psychology of Speech and Hearing Disorders, II. Same as Psychology 484. A survey of psychological techniques utilized in the clinical and experimental study of speech and hearing disorders, with special reference to hearing disorders. Review of research findings and development of experimental designs. 1 unit. Prerequisite: Consent of instructor. O'NEILL.

486. Advanced Clinical Techniques in Speech and Hearing. Semi-independent management of complex cases; participation in examination and analysis. The following topics are offered each semester: theory of clinical practice, speech pathology, audiology, language disorders, field study. ½ to 4 units. Prerequisite: Consent of instructor.

488. Diagnostic Procedures in Pathologies of Speech and Language. Study of diagnostic procedures used in the analysis of neuropathologies of speech and language and orofacial and laryngeal pathologies of speech. 1 unit. Prerequisite: Consent of instructor.

489. Seminar in Orofacial and Laryngeal Pathologies of Speech. Advanced study of speech and vocal problems associated with cleft palate, laryngeal dysfunctions, and facial-maxillary disturbances. The following topics are offered in rotation, one each semester: cleft palate, organic vocal problems. 1 unit; may be repeated for a maximum of two units. Prerequisite: Consent of instructor.

490. Medical Aspects of Speech Disorders and Audiology. Study of acute and chronic hearing and speech disorders traceable to disease of the ear and vocal mechanisms in relation to the techniques and philosophies utilized in a medically oriented environment. 1 unit. Prerequisite: Speech 385, 388, and 486. O'NEILL.

491. Seminar in Hearing Disorders. Principles and methods of clinical management of all types of hearing disorders. Survey of current literature and research. The following topics are offered in rotation, one or two each semester: automatic audiometry, aural rehabilitation, hearing aids and amplification. 1 unit; may be repeated for maximum of three units. Prerequisite: Speech 391.

492. Advanced Audiology. Advanced study of rationale and development of principles associated with special techniques, procedures, and methods used in audiology. 1 unit. Prerequisite: Speech 395 and 397. STARK.

495. Special Problems. Individual investigation of special projects not included in theses. Open to master's candidates for one unit, to doctor's candidates for one or two units. 1 to 2 units. Prerequisite: Consent of head of department. STAFF.

499. Thesis Research. 0 to 4 units. BATEMAN, BEHRINGER, BROADRICK, BURNS, CLARK, DANILOFF, HEWITT, INCE, MACLAY, MURPHY, NEBERGALL, NICHOLS, O'NEILL, SCOTT, SHATTUCK, SHRINER, SILVERMAN, STARK, WENZEL, ZEMLIN.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

301. General Phonetics. Basic principles of phonetic study, including observation and representation of pronunciation; ear training; practice in transcription. ½ or 1 unit. PADEN.

307. The Art of the Screen: Narration. Same as Communications 307. Critical study of the adaptation and synthesis of principles of drama, literature, the graphic arts, and music in the evolution of the screen narrative. Lectures, discussions, and reports; viewing of selected films and television programs. ½ unit. Prerequisite: Training in critical approaches to literature, drama, art, or music; consent of instructor. MUELLER.

308. The Art of the Screen: Exposition and Persuasion. Same as Communications 308. Critical study of the application of the eclectic principles of the screen narrative to the transmission of information and the influencing of attitude, opinion, and action. Lectures, discussions, and reports; viewing of selected films and television programs. ½ unit. Prerequisite: Speech 307 or consent of instructor. The prerequisite does not apply to students of library science who have obtained the necessary background through independent reading. MUELLER.

311. British Public Address. Study of representative British speakers and speeches from earliest times to the present. ½ or 1 unit. MURPHY.

312. American Public Address. Study of representative American speeches from the sixteenth century to the present. ½ or 1 unit. BROADRICK.

313. Interpersonal Communication: Discussion and Interview. Advanced study of theory, research, techniques, and training methods in interviewing and group discussion; emphasis on empirical research findings concerning communication processes in face-to-face groups. ½ or 1 unit. Prerequisite: Consent of instructor.

320. Theory of Argumentation. Study of the philosophical, logical, and psychological bases of argumentation and their implications for public and educational debate and discussion. ½ or 1 unit. Prerequisite: Speech 121 or consent of instructor. WENZEL.

321. Theories of Persuasion and Rhetorical Practice. A survey of theories of persuasion derived from rhetorical, philosophical, and psychological sources and their application to persuasive discourse. ½ or 1 unit. Prerequisite: Consent of instructor.

322. Modern Rhetorical Theory. Significant movements in the development of rhetorical theory in England, France, and America from 1700 to the present. ½ or 1 unit. NICHOLS.

323. Rhetorical Criticism. Methods of interpreting and judging persuasive discourse with emphasis on political speaking and writing. Lectures and practice in criticism. ½ or 1 unit. Prerequisite: Credit or registration in Speech 311, 312, or 322. NICHOLS.

325. Rhetorical Theory in the English Renaissance. Study of the principles of rhetoric in

England, 1500-1700, including their application to selected literature and speeches of the period. ½ or 1 unit.

333. Style and Delivery. Study of verbal and nonverbal features of communicative and expressive utterance. ½ or 1 unit. Prerequisite: A sophomore course in composition (written or spoken) or consent of instructor.

342. Oral Interpretation of Poetry. Analysis and oral presentation of literature representative of various poetic forms. ½ or 1 unit. Prerequisite: Speech 141. BURNS, MACLAY.

344. Criticism of the Oral Interpretation of Literature. Examination of theories of aesthetics and practical criticism and their application to the criticism of specific examples of the oral performance of literature. ½ or 1 unit. Prerequisite: Speech 141, or graduate standing, or consent of instructor.

345. Contemporary Approaches to Oral Interpretation. Modern concepts underlying the relationship of interpretation to the reader's experience of literature; discussions, reports, oral interpretations of prose forms (including Chamber Theatre and Readers Theatre). ½ or 1 unit. Prerequisite: Speech 141 or consent of instructor. MACLAY.

346. Introduction to Folklore: History, Theory, Methods. Same as English, Comparative Literature, German, and Slavic Languages 394. An introduction to the study of folklore with emphasis on folk cultures in the Old and New World; an historical survey of the development of folklore study, an analysis of the methods and genres of folklore, and an introduction to field collecting and evaluation of archival materials. ¾ unit. Prerequisite: A reading knowledge of one modern foreign language is recommended.

352. Introduction to Modern Theatre Art. Same as Theatre 352. Origins and development of modern theatrical production; a critical examination of contemporary ideas and practices in theatre architecture, acting, directing, and staging. ½ or 1 unit. HEWITT.

361. History of the European Theatre to the Renaissance. Same as Theatre 361. The theatre and the theatre arts of ancient and of medieval Europe. ½ or 1 unit. SCOTT.

362. History of the European Theatre from the Renaissance to 1900. Same as Theatre 362. The European theatre and the theatre arts from 1576 to 1900, with special reference to the English theatre. ½ or 1 unit. SCOTT.

363. Advanced Dramatic Writing. Same as English 363, Radio and Television 363, and Theatre 380. Application of principles of dramatic form and structure to the more complex problems of playwriting. Practice in writing sustained dramatic forms. ½ or 1 unit; students may accumulate 2 units of credit. Prerequisite: Speech 263 or equivalent; consent of instructor.

366. Development of the American Theatre. Same as Theatre 366. The development of the theatre and of theatre arts in America from colonial times to the beginning of the twentieth century. ½ or 1 unit. HEWITT.

371. History and Principles of Literary and Rhetorical Criticism: Aristotle to Sidney. Same as English 371. ½ or 1 unit.

372. History and Principles of Literary and Rhetorical Criticism: Sidney to the Present. Same as English 372. ½ or 1 unit.

375. Speech Science, I. Same as Linguistics 375. Introduction to the anatomical and physiological characteristics of the normal speech and hearing mechanisms. ½ unit. Prerequisite: Speech 109 or 301, or consent of instructor. ZEMLIN.

376. Speech Science, II. Same as Linguistics 376. Consideration of the physiology of the speaking act, the acoustical characteristics of voice and speech sounds, and the hearing of speech. ½ unit. Prerequisite: Speech 375 or consent of instructor. ZEMLIN.

377. The Bases of Speech and Hearing Science. An introduction to the anatomical and physiological characteristics of the normal speech and hearing mechanisms, the acoustical characteristics of speech, and the hearing of speech. Not open to students with credit

in Speech 375 or 376. ½ unit. Prerequisite: Speech 109 or equivalent; consent of instructor.

378. Hearing Science. Acoustics, anatomy, and physiology of the auditory system; psychophysical methods and a consideration of auditory theories and mechanics. ½ unit. Prerequisite: Speech 375.

383. Development of Spoken Language. A study of the correlates of language development from the prelinguistic period to adulthood. ½ or 1 unit. Prerequisite: Consent of instructor.

385. Speech Pathology, I. Study of the causes, symptoms, and treatment of speech disorders, including articulatory, vocal, and rhythmical disorders; observation of clinical techniques is required. ½ unit. Prerequisite: Ten hours of speech including Speech 109 and credit or registration in Speech 375, or consent of instructor. SIMPSON.

386. Basic Diagnostic and Therapeutic Principles of Speech Correction. Instruction and practice in the administration and interpretation of diagnostic tests; discussion and demonstration of clinical approaches used with speech disorders. ½ unit. Prerequisite: Speech 385; credit or registration in Speech 388.

387. Practicum in Speech Diagnosis and Therapy. Observation, practice, and research in diagnosis and therapy of speech disorder. ½ unit. Prerequisite: Speech 386 and 389; grade-point average of at least 3.5; consent of instructor.

388. Speech Pathology, II. Study of causes, symptoms, and treatment of speech disorders, including stuttering, cerebral palsy, aphasia, and cleft palate. ½ or 1 unit. Prerequisite: Speech 385. SIMPSON.

389. Psychological Appraisal in Speech Pathology and Audiology. An introduction to principles of diagnostic testing; discussion of administration, scoring, and interpretation of tests used to supplement data obtained during speech, language, and hearing evaluation. ½ unit. Prerequisite: Speech 383 and 385, a course in tests and measurement, or consent of instructor.

390. Communication Disorders in Children: Habilitation and Rehabilitation. Principles of differential diagnosis, therapeutic diagnosis, clinical and classroom habilitation and rehabilitation of children with communicative disorders etiologically associated with neurological impairment, emotional disturbance, environmental deprivation, bilingualism, and mental retardation. ½ or 1 unit. Prerequisite: Speech 383; consent of instructor.

391. Introduction to Hearing Disorders. Analysis of symptoms and causes of hearing losses; effects of hearing loss upon oral communication, education, and psychological adjustment; principles of retraining the hard-of-hearing. ½ unit. Prerequisite: Speech 375 and 378, or consent of instructor. STARK.

392. Seminar in Development and Measurement of Spoken Language. A review of the research and practical methodology associated with the development and measurement of spoken language. 1 unit. Prerequisite: Speech 383 or consent of instructor.

393. Aural Rehabilitation. Principles and methods of clinical and classroom retraining of the hard-of-hearing, including lip reading, auditory training, speech correction and conservation, counseling. Required in curriculum of teacher training in speech correction. ½ or 1 unit. Prerequisite: Speech 391; a grade-point average of at least 3.5; consent of instructor. NASCA.

394. Hearing Conservation. A survey of auditory screening methods, educational and protective measures, and follow-up procedures utilized in public health, public school, and college, military, and industrial settings. ½ or 1 unit. Prerequisite: Speech 391 and 395.

395. Audiometry. Principles and application of basic audiometry. ½ or 1 unit. Prerequisite: Speech 391 or consent of instructor.

396. Diagnosis of Hearing Impairments in Infants and Young Children. Symptoms and causes of hearing impairment in young children; practice in procedures used for the

measurement of residual hearing; selection and use of hearing aids. ½ or 1 unit. Prerequisite: Speech 391 and 395, or consent of instructor.

397. Measurement of Auditory Perception. Principles and methods of clinical assessment of auditory perception. Intensive study of measurement techniques for speech perception; applications with clinical clients; survey of current literature and research. ½ or 1 unit. Offered in 1971-1972 and in alternate years. Prerequisite: Speech 391 and 395. O'Neill.

398. Practicum in Audiology. Observation, practice, and research in diagnosis and rehabilitation of auditory disorders. ½ unit. Prerequisite: Speech 389 and 393. Stark.

399. Design and Analysis of Experiments in Speech and Hearing Science. An introduction to experimental designs and methods of statistical analysis in speech and hearing research. ½ or 1 unit. Prerequisite: Graduate standing or consent of instructor.

THEATRE

The Department of Theatre offers the Master of Arts. Students interested in a doctoral program should meet the requirements for the Ph.D. in Speech with a theatre option. For further information, see descriptive material given under the Department of Speech, page 377.

Master of Arts. Admission requirements are a grade-point average of at least 3.5 and (1) and undergraduate major in theatre, which includes at least nine hours in dramatic literature either as part of the major or in addition to the major, or (2) any undergraduate major, which includes at least nine hours of basic courses in theatre (acting, direction, production) and seven hours in speech or dramatic literature.

Candidates who are deficient in one or more of the above requirements may be admitted provisionally to the program.

Degree requirements are a minimum of six units, including two units in history and theory and two in applied theatre; and a final written examination. A candidate may offer a research thesis for no more than two of the eight units required by the Graduate College.

Doctor of Philosophy in Speech with a Theatre Option. Adminission requirements are a grade-point average of at least 4.0 on a 5.0 scale in the last four semesters of undergraduate and/or graduate work and (1) an undergraduate major in theatre which includes at least nine hours in dramatic literature, either as part of the major or in addition to the major, or (2) an undergraduate major in a related field, such as speech, English, dance, art, radio and television, with at least nine hours of course work in dramatic literature; or a Master of Fine Arts degree in theatre or a Master of Arts degree in theatre, or the equivalent, with a thesis or other evidence of research ability.

Degree requirements are a minimum of eight units beyond the Master of Arts or its equivalent in theatre and related studies; a reading knowledge of two foreign languages; or of one foreign language and one of the prescribed substitutes; and a minimum of eight units of thesis research.

FACULTY

Professors: B. Hewitt (Chairman of Department), Clara M. Behringer, J. W. Scott, C. H. Shattuck.
Associate Professors: Mary H. Arbenz, B. R. Works.
Assistant Professors: J. C. Ahart, D. Llewellyn, R. Tymchyshyn.

COURSES FOR GRADUATES

400. Seminar in Dramatic Form and Structure. Same as Speech 400. Studies in the relationship of dramatic form and structure to the contemporary production of historical and modern plays. 1 unit. Prerequisite: Theatre 361 and 362, or equivalent; consent of instructor.

451. Problems in Play Directing in the Educational Theatre. Same as Speech 451. Study of the audience, play selection, the actor's abilities and needs, tryouts and casting, conduct of rehearsals and methods of directing, the dramatic club, contests and festivals. 1 unit. BEHRINGER.

452. Problems in Play Production in the Educational Theatre. Same as Speech 452. Study of the school auditoria and stages, stage machinery and equipment and their use, lighting facilities and their use, organization of backstage crews, scene shifting and stage management, production problems of special types of plays. 1 unit. BEHRINGER.

461. Advanced Theatre Techniques. Same as Speech 461. Individual development of advanced techniques of acting and staging through supervised participation in public productions. ½ or 1 unit. Prerequisite: At least one semester of graduate study in the area of theatre; consent of head of department and of instructor.

463. Seminar in the History of Acting. Same as Speech 463. Studies in the history and theory of the art of acting. 1 unit. Students may accumulate maximum credit of two units. Offered in 1971-1972 and in alternate years. ARBENZ.

465. Seminar in Theatre Art. Same as Speech 465. Studies in the aesthetics of the theatre. 1 unit. HEWITT.

466. The American Theatre Since 1900. Same as Speech 466. Major developments in acting, production, playwriting, organization, and operation. 1 unit. BEHRINGER.

468. Seminar in Theatre History. Same as Speech 468. Studies in the history of the theatre. 1 unit. HEWITT.

469. The Stage History of Classic English Plays. Same as Speech and English 469. Analysis and reconstruction of past productions of classic plays, with special reference to Shakespeare. 1 unit. Prerequisite: One year of work in dramatic literature or theatre history; consent of instructor. SHATTUCK.

491. Special Problems. Same as Speech 495. Individual research in selected topics by arrangement with the instructor. ½ to 2 units.

499. Thesis Research. 0 to 2 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Practicum, II. Advanced laboratory in acting, directing, playwriting, theatre management, and the design, construction, and handling of scenery, lighting, sound, properties, costumes, and makeup for public performance. ¼ to ½ unit; may be repeated to a total of two units. Prerequisite: For non-theatre majors, consent of instructor.

351. Styles of Acting for Period Plays. Study and practice of traditional styles of acting in dramas by important playwrights representing major theatrical eras such as Sophocles, Aristophanes, Shakespeare, Racine, Moliere, Congreve, Wilde. Lectures, demonstrations, exercises, performance. ½ unit. Prerequisite: Theatre 261 or consent of instructor. ARBENZ.

352. Introduction to Modern Theatre Art. Same as Speech 352. Origins and development of modern theatrical production; a critical examination of contemporary ideas and practices in theatre architecture, acting, directing, and staging. ½ or 1 unit. AHART.

353. Creative Dramatics for Children. A study of the subject matter and techniques of creative dramatics for children, with laboratory application. ½ or 1 unit. Prerequisite: Consent of instructor. TYMCHYSHYN.

354. Theatre for the Child Audience. A study of the history, objectives, and techniques of play production for the child audience, with laboratory application. ½ or 1 unit. Prerequisite: Consent of instructor. TYMCHYSHYN.

361. History of the European Theatre to the Renaissance. Same as Speech 361. The theatre and the theatre arts of ancient and of medieval Europe. ½ or 1 unit. SCOTT.

362. History of the European Theatre from the Renaissance to 1900. Same as Speech

362. The European theatre and the theatre arts from 1576 to 1900, with special reference to the English theatre. ½ or 1 unit. Scott.

366. Development of the American Theatre. Same as Speech 366. The development of the theatre and of theatre arts in America from colonial times to the beginning of the twentieth century. ½ or 1 unit. Arbenz.

368. History of Theatre Costume. A survey of the history of costumes worn on the stage from the classical Greek period to the present. ½ or 1 unit. Prerequisite: Theatre 120 and 281, or consent of instructor.

370. Stage Scenery Design. Theory and practice of designing stage scenery. ½ or 1 unit. Prerequisite: Theatre 120 or Speech 157 and two of the following: Theatre 255, 352, 361, 362, or consent of instructor. Works.

380. Advanced Dramatic Writing. Same as Speech, English, and Radio and Television 363. Application of principles of dramatic form and structure to the more complex problems of playwriting. Practice in writing sustained dramatic forms. ½ or 1 unit; students may accumulate 2 units of credit. Prerequisite: Theatre 280; consent of instructor.

381. Directing, II. Production problems and techniques of movement and business for non-proscenium staging areas; direction of appropriate scenes for class presentation; study of production practices for the musical play. ½ unit. Prerequisite: Theatre 281.

THEORETICAL AND APPLIED MECHANICS

The Department of Theoretical and Applied Mechanics offers work leading to the Master of Science and Doctor of Philosophy.

Graduate students electing theoretical and applied mechanics as their major usually have a bachelor's degree in engineering. Students having a bachelor's degree with a major in mathematics, computer science, engineering physics, engineering science, and similar areas, who have had the equivalent of the undergraduate courses in mechanics usually required for the bachelor's degree in engineering, however, may also elect to major in theoretical and applied mechanics. Admission requires a 4.0 grade-point average for the last sixty semester hours of work completed in terms of a five-point scale (A = 5.0). Applications of students with grade-point averages below 4.0 but above 3.74 are considered on an individual basis.

Candidates for the Doctor of Philosophy are required to take, in addition to the thesis, at least one-half unit from each of the following areas in the department: (1) applied mathematics, (2) dynamics and vibrations, (3) fluid mechanics, (4) mechanics of solids, (5) materials engineering. A student majoring in one of these areas may elect a second minor in one of the other areas, providing the first minor is outside the department.

A student's courses and research are planned with his adviser.

For the Doctor of Philosophy degree, proficiency in reading one foreign language is required. Passing the Educational Testing Service examination in German, Russian, or French is accepted.

The department has strong programs in the five areas noted below. There are several disciplines, such as biomechanics, that cut across all five areas.

Dynamics. An understanding of the response of a mechanical system to a dynamic environment is basic to the analysis and design of many mechanical systems. Major areas of research include kinematics and kinetics. Research in kinetics usually involves deformable bodies, fluids, and materials behavior. Irregular or random type loading on deformable bodies has been the subject of much research. A statistical approach to the latter problem has made it possible to predict the probability of finding response of a system within a certain range.

Fluid Mechanics. This study concentrates on the fundamental phases of fluid behavior with particular regard to the manner in which fluids flow in technological applications. Both gas and liquid motions are considered. Recent studies have centered on turbulence and boundary layer theory and into laminar viscous flows of physiological systems, including

simulation of cerebral circulation problems. Body flow is being studied in the low Reynolds number range, where fluid inertia effects are appreciable and such factors as wave reflections, head loss, and flow stability at conduit branches are important.

Mechanics of Deformable Bodies. This study concerns load-carrying members or structures that are subjected to various types of loads and to various temperature environments. Methods of analysis follow two distinct phases, experimental or analytical, although the two phases often complement each other. Some experimental research involves two- and three-dimensional photoelasticity, reflective photoelastic coating, brittle coating, foil and semiconductor strain gages. Moire method, holographic methods, and displacement transducers. The analytical phase consists of mathematical theories such as elasticity, elastic stability, plasticity, and viscoelasticity.

Behavior of Engineering Materials. Emphasis is placed both on an understanding of the fundamental factors that control deformation and fracture of materials. Research encompasses studies of metals and nonmetals (including concrete, plastics, glass, and composites) and includes the inherent influence of environment on the mechanical behavior of materials in current and future engineering applications. Research is characterized by study of "analysis models" the results of which are combined with the data from a limited number of experiments to predict the performance of a structural or machine part in service.

Major in Applied Mathematics. Graduate students in theoretical and applied mechanics also may major in applied mathematics. See mathematics (applied), page 292. The student takes at least one-half his work in one or more of the following areas: dynamics, fluid mechanics, material engineering, or mechanics of deformable bodies.

FACULTY

Professors: T. J. Dolan (Head of Department), A. P. Boresi, C. E. Bowman, M. E. Clark, H. T. Corten, G. A. Costello, R. A. Eubanks, P. G. Jones, C. E. Kesler, H. L. Langhaar, R. E. Miller, J. Morrow, J. M. Robertson, O. M. Sidebottom, G. M. Sinclair, J. O. Smith, M. C. Stippes, C. E. Taylor, H. R. Wetenkamp, W. J. Worley.

Associate Professors: A. C. Bianchini, D. E. Carlson, J. W. Murdock.

Assistant Professors: F. Bauling, R. S. Jensen, L. K. Shirely, J. C. Wiley.

COURSES FOR GRADUATES

400. Seminar in Engineering Mechanics. There are many special topics in the field of mechanics such as fracture of metals, creep of materials, etc., in mechanics of solids; fluid flow problems such as the nature of turbulence, boundary layer theory, nature and effects of roughness of boundary, effects of free surface; dynamics problems such as vibration of beams with moving loads, the gyroscope, etc. Certain other topics, such as biomechanics, cut across all areas of mechanics. Such special topics as these are covered in this course. Each semester one or more of these topics is selected and announced as the area to be covered in this course during that semester. 1/4 unit. Staff.

412. Vibration Analysis. Continuation of Theoretical and Applied Mechanics 311. Specific topics are systems of several degrees of freedom; applications of generalized coordinates and Lagrange's equations; boundary value problems in vibration of elastic bodies, including strings, rods, and beams; Stodola's methods; iteration process and matrix procedure; vibrations in reciprocating machines, airplane structures and propellers; impact and transient vibrations; self-excited vibration; stability; nonlinear systems. 1 unit. Prerequisite: Theoretical and Applied Mechanics 311 or equivalent. Jones.

416. Energy Principles in Engineering Mechanics. Designed to introduce the student to the variational principles of mechanics and their applications to engineering problems. The derivation, interpretation, and applications of the principle of virtual displacements, the principle of minimum potential energy, the principle of complementary energy. Castigliano's theorem, Hamilton's principle, and Lagrange's equations of motion con-

stitute the main part of the course. Variational methods of approximation are treated briefly. The material includes numerous illustrative applications to stress analysis of statically determinate and statically indeterminate frames, problems of elastic stability, the theories of rings and curved beams, the theory of elastic plates, vibrations of structures, and wave motions. 1 unit. Prerequisite: Theoretical and Applied Mechanics 451. BORESI, LANGHAAR, TAYLOR.

417. Stochastic Structural Dynamics. Same as Aeronautical and Astronautical Engineering 452. Linear structural dynamics problems treated from a probabilistic point of view; axiomatic probability theory and random processes; the response of linear structures to random excitation; practical problems in aeronautical and astronautical engineering. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 255 or Theoretical and Applied Mechanics 412, or equivalent.

418. Stochastic Processes in Engineering. Supplementing Aeronautical and Astronautical Engineering 452, Electrical Engineering 434, or Theoretical and Applied Mechanics 417 for additional engineering application of stochastic processes. Theories of random pulses and continuous Markov processes and their applications to dynamic and control systems; parametric excitations and stability; nonlinear devices; topics related to system failures. 1 unit. Prerequisite: Aeronautical and Astronautical Engineering 452, Electrical Engineering 434, Theoretical and Applied Mechanics 417, or equivalent.

424. Properties of Engineering Materials. Structure of metals and behavior of materials under various conditions of loading and use, including static, creep, fatigue, and impact; effects of high and low temperature, strain rate, state of stress, and internal structure; criteria of failure; relation of mechanical properties to behavior; significance of mechanical properties; tests and interpretation of test data; material specifications. $\frac{1}{2}$ or 1 unit. CORTEN, SINCLAIR.

425. Mechanics of Inelastic Bodies. The course presents methods of obtaining relations between loads, deformations, stresses, and strains in various members that are stressed beyond the elastic range. Most applications consider both time-independent and time-dependent (creep) inelastic deformations. Some specific topics are straight and curved beams, columns, and beam-columns, fully plastic analysis of statically indeterminate members and structures, torsion of circular and noncircular bars, and torsion-tension of bars of circular cross-section. $\frac{1}{2}$ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 321. SIDEBOTTOM, SMITH.

426. Stress and Deformation in Engineering Components. Continuation of Theoretical and Applied Mechanics 321; energy principles, forces and moments in plane and three-dimensional indeterminate members; beams on elastic support; flat plates, thick-walled cylinders, rotating disks, including temperature stresses; contact stresses and deflections; values and significance of stress concentrations. $\frac{1}{2}$ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 321 or equivalent. SIDEBOTTOM, SMITH.

427. Theories of Mechanical Properties and Behavior of Plain Concrete. Theories used in the design of concrete and the factors affecting the properties and behavior of the material and of the test piece. Behavior of plain concrete under different types of environment and of loading, such as long time, repeated, and tri-axial, are emphasized. The studies involve critical reviews of experimental and analytical investigations. $\frac{1}{2}$ to 1 unit. Prerequisite: Bachelor of Science in engineering. KESLER.

428. Analysis of Nonlinear Systems. Same as Electrical Engineering 428. Singular points and stability considerations are treated. Graphical and analytical methods including the perturbation method, variation of parameters. Galerkin's method, and the Ritz method for solving nonlinear differential equations are considered. 1 unit. Prerequisite: Mathematics 341; consent of instructor. WORLEY.

431. Theory of Ideal Fluid Flow. Together with Theoretical and Applied Mechanics 432, topics in advanced fluid mechanics are covered that are the basis of many modern developments. Ideal fluid theory is concerned with an incompressible fluid of negligible

viscosity. The differential equations of motions are derived and the several methods of obtaining flow solutions are presented: the obtaining of velocity potentials and stream functions by superposition of the effects of source, doublets, and vortices, and by the methods of conformal mapping. Relations for finding the resultant forces and moments on bodies are derived and applied to bodies such as lifting surfaces. Other topics covered include the theory and application of free streamline flows, vortex motions, and surface wave theory. 1 unit. Prerequisite: An elementary course in fluid flow; a course in advanced calculus. ROBERTSON, SHIRELY.

432. Theory of Flow of Viscous Fluids. Although a logical continuation of Theoretical and Applied Mechanics 431, this course need not be taken sequentially. Concerned with the theoretical development, analysis, and solution of incompressible viscous fluid flow problems. Starting with the stress relations occurring in viscous fluids, the differential equations of motion are derived and direct and approximate solutions for laminar flows are developed. Boundary-layer theory is presented and the occurrence of turbulence and its characterization introduced. The basic equations for analyzing turbulent flows are introduced and approximate solution for flows in boundary-layers with and without pressure gradients (and separation) pipes and jets are presented. Includes consideration of experimental observation and application to technological problems. 1 unit. Prerequisite: An elementary course in fluid flow; a course in differential equations. ROBERTSON, SHIRELY.

438. Turbulence. Starting with the statistical modes of characterizing turbulence, discussion covers statistical theory, energy considerations, and nature of turbulence in typical flows. Laboratory experiments are used to illustrate hot wire technique of turbulence measurements and the structure of turbulence. 1 unit. Prerequisite: Theoretical and Applied Mechanics 432 or equivalent. ROBERTSON.

441. Applied Analysis in Engineering. A course to provide training in applications of mathematics to engineering problems. Most of the illustrations are taken from engineering mechanics. 1 unit. Prerequisite: Mathematics 143; Mathematics 343 and 345 are recommended. COSTELLO, LANGHAAR, MILLER.

442. Applied Analysis in Engineering. Continuation of Theoertical and Applied Mechanics 441. 1 unit. Prerequisite: Mathematics 143; Mathematics 343 and 345 are recommended. COSTELLO, LANGHAAR, MILLER.

451. Theory of Elasticity with Application to Engineering Problems. A study of the mechanics of elastic deformable bodies, based on the fundamental concepts of equilibrium, geometry of strain, and properties of materials. Relations between stresses, strains, and displacements are studied in detail with special consideration given to their significance in engineering problems. 1 unit. Prerequisite: Theoretical and Applied Mechanics 221; Mathematics 343; Mathematics 341 or equivalent. BORESI, EUBANKS, LANGHAAR, MILLER, TAYLOR.

452. Theory of Elasticity with Application to Engineering Problems. Continuation of Theoretical and Applied Mechanics 451. 1 unit. Prerequisite: Theoretical and Applied Mechanics 451. BORESI, LANGHAAR, STIPPES.

454. Theory of Shells. A course designed to provide the theoretical basis of stress analysis of shell-type structures, such as ships, submarines, monocoque aircraft structures, concrete roofs and domes, pressure vessels, and containers for liquids. The material includes the differential geometry of shell theory, equilibrium equations, momentless theory of shells, strains in shells, statically indeterminate problems of shells, energy formulations, and stability of shells. 1 unit. Prerequisite: Theoretical and Applied Mechanics 451. BORESI, LANGHAAR.

457. Classical Elastostatics. A modern unified treatment of the concepts and techniques developed in the course of investigation of the Cauchy-Navier equations. Emphasis on the interpretation and motivation of ideas and their interrelation for the solution of three-dimensional problems. Topics include the classical boundary-value problems, existence and uniqueness theorems, stress functions and displacement potentials, singular states of

stress, extension of Green's method to the equations of elasticity, method of series, and approximation techniques. Course represents a preparation for (1) students interested in the current state of knowledge in classical elasticity, and (2) students intending to do doctoral dissertations in classical elasticity. 1 unit. Prerequisite: Theoretical and Applied Mechanics 451 or equivalent; consent of instructor. STIPPES.

458. Wave Motion in Continuous Media. An analysis of the dynamics of deformable bodies with a major emphasis on elastic media. Introduces the terminology associated with and the methods of treating such problems. Includes a general discussion of the motion of strings, bars, shafts, plates, and other bodies when subjected to load. Detailed examination of approximations involved is made and their engineering significance is discussed. 1 unit. Prerequisite: Theoretical and Applied Mechanics 311, 314, 451; Mathematics 341, 342, 343, or equivalent. EUBANKS, STIPPES.

460. Continuum Mechanics, II. Continuation of Theoretical and Applied Mechanics 360. Viscous fluids (without memory) and elastic bodies as examples of simple materials, general principles of continuum thermodynamics, thermodynamics of elastic bodies, selected topics in modern continuum mechanics. 1 unit. Prerequisite: Theoretical and Applied Mechanics 360.

462. Theory of Plasticity. The physical and mathematical formulation of the mechanics of inelastically deformed bodies, plastic stress-strain laws, and their association with yield and loading function. Deals primarily with members subjected to bi-axial and tri-axial stress conditions. Specific topics include applications to flexure and torsion of prismatic members; expansion of thick-walled cylinders and spherical shells; introduction to problems in plane plastic flow and variational plasticity. ½ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 451 or equivalent. SIDEBOTTOM.

464. Theory of Buckling. The pertinent information and theoretical background required for the prediction of failure by buckling of structures such as airplanes, ships, bridge trusses, fabricated towers and shells; practical illustrations. Specific topics are elastic columns with various end restraints; buckling of frameworks, arches, rings, and plates; inelastic buckling of columns and plates; lateral buckling of beams; energy theory; Ritz procedure; Euler's equation of the calculus of variations. ½ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 416 and 451. COSTELLO, LANGHAAR.

467. Thermomechanics of Nuclear Reactor Systems. Same as Nuclear Engineering 467. Origin of thermomechanics problems in nuclear reactor systems; heat generation and transfer in nuclear power systems; thermal stress in nuclear reactor systems; dynamical theory including effects of thermal-shock and thermal stress-wave propagation; current thermo-mechanics problems in nuclear reactor design. Term paper required. 1 unit. Prerequisite: Nuclear Engineering 401 or consent of instructor. BORESI.

472. Advanced Photoelasticity. Theoretical and practical aspects of modern photoelasticity. Topics include: three-dimensional photoelasticity, birefringent coatings, dynamic photoelasticity, photoplasticity, photoviscoelasticity, and photothermoelasticity. 1 unit. Prerequisite: Theoretical and Applied Mechanics 326, 451, or consent of instructor. TAYLOR.

485. Fracture Mechanics. Designed to acquaint students with the analytical and experimental techniques used to solve current fracture problems. Topics include (1) a discussion of the macroscopic theories used to determine the static strength of bodies containing cracks, (2) linear elastic fracture mechanics—the tool and the model—its relation to the Griffith criteria of fracture, (3) elastic-plastic fracture mechanics models—small scale-yielding results and their implication, (4) an introduction to fracture mechanics in the realm of general yielding. Examples of how the analytical methods can be applied are derived from discussion of the general fracture control plan. 1 unit. Prerequisite: Theoretical and Applied Mechanics 324 and 451, or consent of instructor.

493. Advanced Independent Study (Special Problems). Analytical or experimental studies in one or more phases of theoretical and applied mechanics, including mechanics

of materials, theory of elasticity, theory of plasticity, properties of materials, mechanical vibrations, hydraulics and fluid mechanics, fatigue of metals, etc. ½ to 2 units. STAFF.

499. Thesis Research. 0 to 4 units. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

311. Mechanical Vibrations. Kinematics of vibratory motion; comprehensive study of motion having single degree of freedom; critical speeds of shafts; vibration of systems with several degrees of freedom. Applications to engineering problems. Credit is not given for both Civil Engineering 374 and Theoretical and Applied Mechanics 311. ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 154 or 156, or 211 or 212, and 221.

314. Advanced Dynamics for Engineers. Three-dimensional kinematics of a rigid body, general dynamics of a rigid body, moments and products of inertia, kinetic energy, rotation of a rigid body about a fixed axis and about a fixed point, Euler equations of motion, gyroscopic theory; introduction to Lagrange equations; engineering applications. 1 unit. Prerequisite: Theoretical and Applied Mechanics 211 or equivalent; Mathematics 341 or 345.

315. Advanced Dynamics with Applications to Engineering Problems. General advanced methods of dynamics are discussed. Some emphasis is placed on the behavior of special components of guidance and control systems. Associated engineering problems are treated. Topics: Lagrange equations and Hamiltonian canonical equations; Hamiltonian methods; theory of vibrations; special theory of relativity, gyroscopic compass; gyroscopic stabilizer; modern gyroscopes; astronomical applications. 1 unit. Prerequisite: Theoretical and Applied Mechanics 314 or equivalent.

321. Advanced Mechanics of Deformable Bodies. Basic concepts of mechanics of deformable bodies and brief review of elementary topics; theory of stress and strain at a point; theories of failure, including failure by fracture; unsymmetrical bending; curved beams; torsion of noncircular sections; energy principles; Castigliano's theorem. ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 221 and 223 or 224.

324. Flow and Fracture of Structural Metals. Fundamental concepts of strength of crystalline engineering materials at atomic, single crystal, and polycrystalline levels of association in relation to engineering mechanisms of failure; functional relationship between material variables, state of stress, strain, time, temperature, and failure of engineering components by creep, stress rupture, fatigue, and brittle fracture. ¾ unit. Prerequisite: Theoretical and Applied Mechanics 221 and 224, or consent of instructor.

326. Experimental Stress Analysis. Measurement of stresses or deformations that are of significance in the engineering design of load-resisting members; use of optical, electrical, and mechanical instrumentation, models, analogies, brittle coatings, electrical resistance gages, photoelasticity, etc. ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 150, 211, 212, 221, and 223 or 224. Theoretical and Applied Mechanics 321 is desirable.

334. Fluid Mechanics and Advanced Hydraulics. A study of the basic properties of fluids in general, particularly those that influence the flow of fluids in pipes and open channels, viscosimetry, dimensional analysis, effect of boundary conditions, cavitation, water tunnel, hydraulic jump, water hammer, pumps, turbines. Some laboratory work. ½ to 1 unit. Prerequisite: Theoretical and Applied Mechanics 235.

335. Dynamics of Fluids. An intermediate course in the mechanics of fluids, introducing analytical methods of solution for ideal and real fluids. Potential flow theory, theoretical approaches to viscous flows including boundary-layer theory, and the analysis of compressible flows are indicated. ¾ or 1 unit. Prerequisite: Theoretical and Applied Mechanics 235.

346. Dimensional Analysis and Theory of Models. The nature and use of dimensions, systematic calculation of dimensionless products, algebraic theory of dimensional anal-

ysis, similarity and model laws, and derivation of model laws from differential equations. Applications include von Karman's theory of similarity in turbulent flow, boundary-layer theory, topics in open channel flow, model laws for pumps and turbines, topics in structural analysis and vibration theory, topics in the theory of heat. ½ or 1 unit.

351. Fundamental Concepts of Deformable Body Mechanics. This course is intended to provide an introduction to the general theories of kinematics of deformable bodies, general balance laws applicable to continuum mechanics, constitutive relations (stress-strain relations) as well as introductions to linear elasticity, linear viscoelasticity, and special concepts in other areas of solid mechanics and fluids. 1 unit. Prerequisite: Theoretical and Applied Mechanics 221; Mathematics 343 and 345.

360. Continuum Mechanics, I. A unified treatment of modern continuum mechanics: linear algebra and analysis, review of kinematics and general balance laws, general theory of mechanical constitutive equations (simple materials). 1 unit. Prerequisite: Theoretical and Applied Mechanics 351 or equivalent.

373. Engineering Acoustics. Same as Electrical Engineering 373. Development of the basic concepts needed for the understanding of mechanical and electric acoustic systems: vibrating string, vibrating membrane, plane waves, spherical waves, vibrating piston, acoustical filters, loudspeakers and microphones, principle of reciprocity, the ear, architectural acoustics. ¾ or 1 unit. Prerequisite: Mathematics 345 or equivalent, or consent of instructor.

392. Analysis and Synthesis of Problems. This course emphasizes the rational analysis of comprehensive problems and engineering systems. ½ to 1 unit. Prerequisite: Consent of instructor.

URBAN PLANNING

The Department of Urban Planning offers work leading to the master's degree. Students applying for admission must have a grade-point average of at least 3.75.

Master of Urban Planning. College graduates in liberal arts and sciences as well as architecture, urban planning, civil engineering, and landscape architecture can prepare themselves for careers in city, state, and regional planning.

The graduate program typically requires two years in residence, but a student with an undergraduate degree in urban planning may complete the program in a shorter period.

Specialization is encouraged, especially during the second year, in such directions as quantitative methods, social policies planning, implementation and intergovernmental relations, and urban design.

To qualify for this degree, a student must take (1) a total of at least six units of urban planning, and (2) at least two additional units to be chosen from the following fields: architecture, civil engineering, economics, geography, landscape architecture, political science, or sociology.

FACULTY

Professors: W. I. Goodman (Chairman of Department), S. Keyes, L. B. Wetmore.
Associate Professors: L. F. Blair, E. C. Freund, A. Z. Guttenberg, R. J. Heifetz.
Assistant Professor: J. E. Urbonas.

COURSES FOR GRADUATES

437. Advanced Urban Planning Studio. Analysis and synthesis problems related to design and development programming for cities, metropolitan areas, and urban regions. 1 to 2 units. Prerequisite: Urban Planning 337, 338, and 374, or consent of instructor.

487. Seminar. ½ unit. Prerequisite: Urban Planning 374.

488. Urban Planning Research. Individual and group instruction in the application of professional competences in urban planning to the analysis of urban development problems and to the formulation of approaches to solution of such problems. ½ to 2 units. Prerequisite: Urban Planning 171 or consent of instructor.

492. Seminar on Models for Directed Change. Same as Sociology and Social Work 492. Construction and analysis of models for planned intervention at the personal, small group, and community levels. Construction of models as interpretations of behavioral science theory; extrapolating of hypotheses and of guides to intervention from the models. Readings from several disciplines as relevant. ½ or 1 unit. Prerequisite: Consent of instructor.

499. Thesis Research. ½ to 2 units. Prerequisite: Graduate standing in urban planning. STAFF.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

337. Urban Planning Studio, II. The theory and development of the planning process as it applies to the study of an existing community, including visual surveys, data collection and analysis, "momentum projections," plan making, and implementation programs. 1 to 1½ units. Prerequisite: Urban Planning 236 or consent of instructor.

338. Urban Planning Studio, III. Contemporary theories of urban design and structure; planning and design of new communities; circulation and public facilities systems; studies of alternative patterns of growth. 1 to ½ units. Prerequisite: Urban Planning 337 or consent of instructor.

351. History of Urban Planning. Description and analysis of the development of urbanization and the planning of communities from ancient times to the present, as related to environmental and cultural influences. ½ unit. Prerequisite: Urban Planning 171 or consent of instructor.

374. Urban Planning Theory. An examination of the urban planning function within a theoretical, methodological, institutional, and professional context. ½ unit. Prerequisite: Urban Planning 171 or consent of instructor.

376. Planning Analysis. Research and analytic techniques in urban planning; economic base and employment, population, market analysis; derivation and employment, population, market analysis; derivation and use of statistical data. ½ unit. Prerequisite: Urban Planning 171 or consent of instructor.

377. Comprehensive Planning Procedure. Design and plan-making techniques in urban planning; land use, circulation and community facilities; the development of the comprehensive general plan. ½ unit. Prerequisite: Urban Planning 171.

378. Planning Legislation and Administration. Legal tools of planning, zoning, subdivision regulations; housing codes; methodology and application; administrative procedures; the place of planning in the structure of governments; the capital improvement program. ½ unit. Prerequisite: Political Science 150, 151, or 305, 306, or consent of instructor.

380. Survey of Regional Planning. Concepts and procedures for planning of regions: river valley, metropolitan, state, and national planning. ½ unit. Prerequisite: Urban Planning 171 or consent of instructor.

382. The Language and Thought of Urban Planning. The nature of urban planning thought; the meaning of its basic terms and concepts; the philosophic issues and choices of meaning facing the future professional; trends of thought in urban planning literature. ½ unit. Prerequisite: Consent of instructor.

384. Urban Design and Planning Methods. Concepts and techniques of urban analysis, plan making and implementation essential for effective interdisciplinary work in urban design; case studies of major types of large-scale projects. ¾ unit. Prerequisite: Urban Planning 171 or consent of instructor.

VETERINARY MEDICAL SCIENCE

Candidates for the Master of Science and Doctor of Philosophy in Veterinary Medical Science must have a Bachelor of Science or a Doctor of Veterinary Medicine from a college or university approved by the University of Illinois. If they do not have a veterinary medical degree, their undergraduate training must be approved by the graduate faculty of the department as appropriate to advanced study. They must have a minimum grade-point average of 4.0. Applications of students with grade-point averages below 4.0 but above 3.75 are considered on an individual basis.

Areas of specialized study in veterinary medical science include biological structure, microbiology, parasitology, pathology, physiology, and pharmacology.

Students who intend to take graduate work for a Master of Science or Doctor of Philosophy in Veterinary Medical Science should include in their undergraduate program at least five hours of physics or mathematics, fourteen hours of chemistry, and fifteen hours of biological sciences.

Students planning to work toward the Doctor of Philosophy who enter the University of Illinois without previous graduate training are evaluated by the graduate faculty of the department at the end of their first year of residence in order to determine whether their progress is acceptable for work toward the doctorate. This evaluation is based in part upon an examination.

Departmental requirements for the Master of Science or Doctor of Philosophy in Veterinary Medical Science are described in a pamphlet which may be obtained from the office of the Dean of the College of Veterinary Medicine.

FACULTY

Professors: L. M. Jones (Dean of College of Veterinary Medicine), P. D. Beamer, L. E. Boley, P. R. Fitzgerald, H. W. Hannah, L. E. Hanson, H. J. Hardenbrook, R. D. Hatch, W. G. Huber, N. D. Levine, R. P. Link, J. E. Lovell, M. Ristic, L. E. St. Clair, A. G. Schiller, D. Segre, P. H. Silverman, J. Simon, E. Small, A. M. Watrach, G. T. Woods.

Associate Professors: D. H. Ferris, L. C. Helper, A. H. Killinger, C. D. Knecht, J. P. Manning, R. C. Meyer, W. L. Myers, W. M. Newton, H. A. Reynolds, F. E. Romack, A. H. Safanie, R. Slusher, A. R. Twardock.

Assistant Professors: J. J. B. Anderson, H. F. Downey, G. L. Jackson, Diane K. Normandin, H. E. Rhoades, J. C. Thurmon, K. S. Todd.

COURSES FOR GRADUATES

408. Principles of Hematology. The cellular morphology of the blood and bone marrow of animals in health and disease. Lectures, discussions, demonstrations, and laboratory. $\frac{1}{2}$ unit. Prerequisite: Veterinary Medical Science 301 or equivalent, or consent of instructor.

415. Mechanisms of Microbial Infections. Newer concepts of host-microorganism relations with emphasis on the dynamics and pathogenic mechanisms of microorganisms, immune responses and defense factors of the host, and pathogenesis of specific infections. Lectures, discussions, laboratory, and special problems. $\frac{3}{4}$ unit. Prerequisite: Microbiology 326 or Veterinary Medical Science 332, or equivalent; consent of instructor.

416. Epizootiology. Principles and problems of epizootiology with special consideration of the zoonoses; ecology of the host and parasite as related to resistance, adaptation, perpetuation, and distribution; the principles and factors in interference, carrier and latent states, reservoirs and control. 1 unit. Prerequisite: Veterinary Pathology and Hygiene 331, Veterinary Medical Science 332, or equivalent, or consent of instructor.

417. Medical Mycology. Study of the fungi that cause infections in man and animals; taxonomy, methodology, epidemiology, pathology, and diagnosis. 1 unit. Prerequisite: Microbiology 326, Veterinary Medical Science 332, or equivalent.

418. Concepts and Topics in Immunology. Same as Biology 418. Newer concepts and theories in the field of immunology, including theories of antibody formation and immunologic tolerance, regulation of the immune response, biosynthesis and structure of antibodies, and evolutionary aspects of the immune response. Lectures and discussion. ½ unit. Prerequisite: Consent of instructor. Microbiology 327 and Biology 307 recommended.

419. Animal Virology. Same as Microbiology 419. A discussion-laboratory with major emphasis on host-parasite relationships, natural history and epidemiology supplemented with appropriate laboratory techniques as they pertain to the major groups of animal viruses. ¾ unit. Prerequisite: Microbiology 326 and 327 or Veterinary Medical Science 331 and 332; Chemistry 350 or 354; consent of instructor.

425. Experimental Parasitology. Same as Zoology 425. A broadly based consideration of the relation of parasites to their hosts and to their environments, and of the factors which influence these relationships. 1 unit. Prerequisite: A laboratory course in parasitology or protozoology; organic chemistry; Chemistry 350; biochemistry and statistics are recommended.

440. Design and Analysis of Biological Experiments. Same as Agricultural Engineering, Agronomy, Animal Science, Dairy Science, Food Science, Forestry, and Horticulture 440. Statistical methods as tools for research. Principles of designing experiments and methods of analysis for various kinds of designs, including factorial experiments, are considered from the viewpoint of when and how to use them. ¾ unit. Prerequisite: Veterinary Medical Science 340 or equivalent.

445. Advanced Macroscopic Pathology. Concepts and interpretations of gross pathologic changes and the integration of host-parasite reactions. ½ or 1 unit. Prerequisite: Veterinary Medical Science 334 and 335, or equivalent; consent of instructor.

450. Advanced Veterinary Pathology. Advanced study of gross and microscopic pathology of diseases of domestic animals. 1 unit. Prerequisite: Veterinary Medical Science 335 or equivalent.

455. Comparative Oncology. A comparative study of the nature of mammalian and avian neoplasms based on general and special methods of tumor identification, classification, and experimentation. Lectures, demonstrations, and laboratory. 1 unit. Prerequisite: Veterinary Medical Science 445 and 459, or equivalent. Required course for students majoring in pathology in Department of Veterinary Medical Science.

457. Ultrastructural Pathology. Ultrastructural basis of pathologic processes occurring in animal tissues and cells. Lectures, discussions, and reports. ¾ or 1 unit. Prerequisite: Zoology 430; consent of instructor.

459. Advanced Correlative Pathology. Discussion and interpretation of disease processes of domestic animals. Emphasis on the correlation of gross, microscopic, and clinicopathologic findings with alterations of function. 0 to 1½ units. Prerequisite: Veterinary Medical Science 308, 335, 445, 450, or equivalent; consent of instructor.

460. Advanced Veterinary Physiology. Advanced study of physiology, nutrition, and biochemistry as related to problems in veterinary medical science. Problems studied include white muscle disease, sweet clover disease, ketosis, hypoglycemia and digestive disturbances. Laboratory includes planning, executing, and reporting a specific course project. 1 unit. Prerequisite: Veterinary Medical Science 315, 316, or equivalent; consent of instructor.

461. Advanced Veterinary Pharmacology. Evaluation of drugs, pharmacological aspects of biological antagonisms, chemotherapy, antibiotics, chelating agents and chemical biological correlation. ¾ unit. Prerequisite: Consent of instructor.

463. Radioisotopes in Biological Research: Principles and Practice. Same as Animal Science and Biophysics 463. Lectures, demonstrations, and laboratory on the fundamentals of radioisotope procedures and applications in biology and medicine. ¾ unit. Pre-

requisite: Quantitative chemistry; one year each of mathematics, physics, biology, and/or consent of instructor.

464. Mineral Metabolism. Physiology, nutrition, and biochemistry of minerals. Mineral regulatory mechanisms; mineral membrane transport; and mineral abnormalities. Lectures, discussions, and reports. 3/4 unit. Prerequisite: Veterinary Medical Science 316 or Physiology 301 and 302, or equivalent; or consent of instructor.

490. Seminar. Required of all graduate students whose major is veterinary medical science. 1/4 unit.

491. The Experimental Method in Veterinary Research. Planning of experiments, use of controls, interpretation of results, sources of error, and writing the research report. 1/2 unit.

492. Special Problems. Basic and applied study including orientation and research on pertinent initial and continuing problems in the student's area of interest. 1/4 to 1 unit. Prerequisite: Consent of instructor. STAFF.

499. Thesis Research. 0 to 4 units.

COURSES FOR GRADUATES AND ADVANCED UNDERGRADUATES

300. Gross Anatomy. Systematic and topographic study and dissection of the dog. Lectures, discussions, demonstrations, quizzes, and laboratory. 1 unit. Prerequisite: Five hours of zoology; consent of instructor.

301. Histology. Structure of cells, tissues, membranes, vessels, lymphoid organs, hollow organs, skin and organs of special sense with special reference to domestic animals. 1 unit. Prerequisite: Registration in veterinary curriculum or consent of instructor.

302. Gross Anatomy. Comparative study and dissection of the domestic animals with special reference to development and adaptation to function. Lectures, discussions, demonstrations, quizzes, and laboratory. 1 unit. Prerequisite: Veterinary Medical Science 300 and 301, or consent of instructor.

303. Microscopic Organology. Microscopic study of the organ and systems of different domestic animals. Lectures, demonstration, laboratories, and quizzes. 3/4 unit. Prerequisite: Veterinary Medical Science 300 and 301, or consent of instructor.

305. Developmental Anatomy. Development of organs and systems with emphasis on specializations in domestic and laboratory animals. Lectures and quizzes. 3/4 unit. Prerequisite: Veterinary Medical Science 300 and 301, or consent of instructor.

307. Correlative Mammalian Neuroanatomy. Organization of nuclei and tracts of the central nervous system; morphologic specializations related to behavioral peculiarities of domestic and laboratory mammals; gross and microscopic examination of material from primates, rodents, carnivores, and ungulates. 1 unit. Prerequisite: Veterinary Biological Structure 300, Zoology 232, or consent of instructor.

308. Histochemistry. Methods used in histochemical and histological analysis in animals. Lectures, discussions, demonstrations, and laboratory. 1/2 or 1 unit. Prerequisite: Veterinary Medical Science 301 or equivalent, or consent of instructor.

315. Veterinary Physiology. Nervous systems respirations, acid-base balance, urine formation, body fluids and their regulation, muscular systems. Lectures, discussions, and laboratory. 1 1/4 units. Prerequisite: Consent of instructor.

316. Veterinary Physiology and Pharmacology. Blood and lymph, circulation, digestion, metabolism and endocrine systems. Lectures, discussions, and laboratory. 1 unit. Prerequisite: Veterinary Medical Science 315 or consent of instructor.

318. Pharmacology. General principles of pharmacy and an analysis of the action of chemical agents on physiological processes. Lectures, discussions, demonstrations, and laboratory. 1 unit. Prerequisite: Credit or registration in Veterinary Medical Science 315 and 316; consent of instructor.

320. Pharmacology and Toxicology. Principles of drug action and an analysis of action of

chemical agents on living organisms including intoxications of domestic animals. Lectures, discussions, and demonstrations. 1 unit. Prerequisite: Veterinary Medical Science 318 or consent of instructor.

332. Veterinary Microbiology and Immunology. Lectures, discussions, and laboratories dealing with mechanisms of infection and resistance and the properties, pathogenesis, and control of viral infection of domestic and wild animals. 1 unit. Prerequisite: Veterinary Pathology and Hygiene 331 or equivalent; consent of instructor.

333. Protozoan and Arthropod Parasites. Protozoan and arthropod parasites affecting domestic animals and man. Lectures, discussions, and laboratory. ¾ unit. Prerequisite: Courses in chemistry or animal biology or both totaling twenty semester hours; consent of instructor.

334. General Pathology. The basic principles of pathological processes, including tissue injury and repair, circulatory and metabolic disturbances, inflammation and neoplasia. Lectures, quizzes, demonstrations, and laboratory. 1 unit. Prerequisite: Courses in histology, parasitology, physiology, and microbiology totaling twenty-five semester hours; consent of instructor.

335. Special Pathology. Disease processes affecting organs and anatomic systems and those occurring in specific diseases. Lectures, quizzes, demonstrations, and laboratory. 1 unit. Prerequisite: Veterinary Medical Science 334 or equivalent; consent of instructor.

336. Helminth Parasites. Helminth parasites affecting domestic animals and man. Lectures, discussions, and laboratory. ¾ unit. Prerequisite: Courses in chemistry or animal biology or both totaling twenty semester hours; consent of instructor.

340. Introduction to Applied Statistics. Same as Agricultural Engineering, Agronomy, Animal Science, Dairy Science, Food Science, Forestry, and Horticulture 340. Statistical methods involving relationships between populations and samples; collection, organization, and analysis of data; techniques in testing hypotheses with an introduction to regression, correlation, and analyses of variance limited to the completely randomized design and the randomized complete-block design. ¾ unit. Prerequisite: Mathematics 111 or 112 or 104, or equivalent.

346. Management and Diseases of Laboratory Animals. Principles of management of conventional and gnotobiotic laboratories emphasizing proper care, sanitation, breeding procedures, and disease control as fundamental requirements for the production and maintenance of good quality animals for teaching and research. ½ unit. Prerequisite: At least two courses in biology or equivalent; consent of instructor.

369. Introduction to Human Ecology. Same as Anthropology, Geography, Health Education, Physiology, Psychology, Sociology, and Zoology 369. Application of principles of animal ecology to human biology with emphasis on development of man, geographical elements, morphological adaptations, and physiological, psychological, and sociological adjustments to environment, regulation of populations, and control of the environmental regulating factors. ½ or 1 unit. Prerequisite: One year of biology; one year of anthropology, geography, geology, or sociology.

374. Problems in Human Ecology. Same as Anthropology, Geography, Health Education, Physiology, Psychology, and Sociology 374. Methodologies for investigation of problems in human ecology; effects of specific environmental and social factors; multidisciplinary studies of selected current problems. 1 unit. Prerequisite: Anthropology, Geography, Health Education, Physiology, Psychology, Sociology, or Zoology 369.

392. Special Problems. Individual research on a special problem chosen in consultation with the instructor and department head. ½ unit. May be repeated for a total of one unit. Prerequisite: Registration in veterinary medical curriculum with grade-point average of 3.5 or above. STAFF.

ZOOLOGY

See descriptions and course listings under Life Sciences, page 272.

UNIVERSITY OF ILLINOIS

Where to Write

ADMISSION
Office of Admissions and Records
100a Administration Building, Urbana 61801
or
The Graduate College
330 Administration Building, Urbana 61801

CHICAGO CIRCLE
The Graduate College
P.O. Box 4348, Chicago 60680

EMPLOYMENT (Hourly)
Director, Student Employment
Room 109, 707 South Sixth Street, Champaign 61820

EXTRAMURAL CLASSES
Division of University Extension
101 Illini Hall, Champaign 61820

FELLOWSHIPS, ASSISTANTSHIPS, OTHER FINANCIAL AID
The Graduate College
330 Administration Building, Urbana 61801
or the prospective major department

FOREIGN STUDENTS (Passport, Visa Assistance)
Director, Office of Foreign Student Affairs
310 Student Services Building, Champaign 61820

HOUSING
Director, Housing Division
420 Student Services Building, Champaign 61820

MEDICAL CENTER (Medical and Dental Sciences, Nursing, Pharmacy)
The Graduate College
P.O. Box 6998, Chicago 60680

MOTOR VEHICLE AND BICYCLE REGISTRATION
Motor Vehicle Registration Office
101 North Mathews Avenue, Urbana 61801

PUBLICATIONS
Graduate College Catalog; Time Table; Calendar;
Financial Aid for Graduate Students;
Saturday, Late Afternoon, and Evening Classes for Teachers
The Graduate College
330 Administration Building, Urbana 61801

DEPARTMENTAL BROCHURES
The prospective major department

SERVICES FOR PERMANENTLY PHYSICALLY HANDICAPPED STUDENTS
Division of Rehabilitation-Education Services
Rehabilitation-Education Center, Champaign 61820

VETERANS
Veterans Educational Benefits
Room 109, 707 South Sixth Street, Champaign 61820

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